DOCUMENT RESUME

ED 397 423 CS 215 363

AUTHOR	Hull, Glynda; And Others
TITLE	Changing Work, Changing Literacy? A Study of Skill Requirements and Development in a Traditional and Restructured Workplace. Final Report.
INSTITUTION	National Center for the Study of Writing and Literacy, Berkeley, CA.; National Center for the Study of Writing and Literacy, Pittsburgh, PA.
SPONS AGENCY	Office of Educational Research and Improvement (ED), Washington, DC.
PUB DATE	Feb 96
CONTRACT	R117G10036
NOTE	323p.; Project also funded by the National Center for Research in Vocational Education.
PUB TYPE	Reports - Evaluative/Feasibility (142)
EDRS PRICE	MF01/PC13 Plus Postage.
DESCRIPTORS	Ethnography; Higher Education; *Literacy; Organizational Climate; *Reading Skills; Work Environment; *Workplace Literacy; *Writing Skills
IDENTIFIERS	*Reading Uses; Silicon Valley; *Writing Contexts

ABSTRACT

A study (1) identified in ethnographic detail the literacy-related skills that are required in today's changing workplaces; (2) compared the literacy requirements of "high performance" workplaces with more traditionally organized ones; and (3) constructed innovative ways to introduce educators to the changing skill demands of work. The 3-year project studied circuit board assembly or "contract manufacturing" in the Silicon Valley, a rapidly growing and highly competitive part of the electronics industry. The varied functions that reading and writing served in such work environments were identified, and the ways in which industry standards and work organization, such as self-directed work teams, affect literacy requirements for a range of workers at individual companies were documented. How literacy requirements varied in these factories were determined, given different types of work organization; and the constraints that companies themselves exerted in the exercise of literate abilities were identified. A multimedia data base (a computer-base compendium of video from the factory floors; audiotaped interviews with line workers, engineers, and managers; examples of written documents and schematic diagrams and other data--is being built and field-tested which can be used to introduce vocational and literacy educators, in dynamic fashion, to the literacy requirements of changing workplaces. (Contains 16 figures, 1 table of data, 8 notes, and 81 references. The 17 appendixes present log reports and procedures, transcripts, meta-categories worksheets and frequencies, and taxonomies of team activities and classroom activities.) (Author/RS)

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FINAL REPORT

CHANGING WORK, CHANGING LITERACY? A STUDY OF SKILL REQUIREMENTS AND DEVELOPMENT IN A TRADITIONAL AND RESTRUCTURED WORKPLACE

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February, 1996

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NOTE: The research reported herein was supported under the Educational Research and Development Center Program (R117G10036 for the National Center for the Study of Writing) as administered by the Office of Educational Research and Improvement, U.S. Department of Education. The findings and opinions expressed in this report do not reflect the position or policies of the Office of Educational Research and Improvement or the U.S. Department of Education.

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ACKNOWLEDGMENTS

This project was funded through the National Center for Research in Vocational Education and the National Center for the Study of Writing and Literacy, and we gratefully acknowledge that support. We especially thank the directors of those Centers, W. Norton Grubb and Sarah Warshauer Freedman respectively, for their interest and guidance. The project has benefited as well from the considerable talents of its research team, which included Meg Gebhard, Brian Reilly, Kathy Schultz, and Craig Wilson. Finally, we thank the line workers, supervisors, engineers and managers we came to know through this project. We hope the following report does justice to their working lives.

CHANGING WORK, CHANGING LITERACY? A STUDY OF SKILL REQUIREMENTS AND DEVELOPMENT IN A TRADITIONAL AND RESTRUCTURED WORKPLACE

FINAL REPORT

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Abstract

The purpose of this project was (1) to identify in ethnographic detail the literacy-related skills that are required in today's changing workplaces; (2) to compare the literacy requirements of "high performance" workplaces with more traditionally organized ones; and (3) to construct innovative ways to introduce educators to the changing skill demands of work. During the past three years we have studied circuit board assembly or "contract manufacturing" in the Silicon Valley, a rapidly growing and highly competitive part of the electronics industry. In so doing, we have identified the varied functions that reading and writing serve in such work environments, and we have documented the ways in which industry standards and work organization, such as self-directed work teams, affect literacy requirements for a range of workers at individual companies. We have determined how literacy requirements vary in these factories, given different types of work organization. And we have identified the constraints that companies themselves exert on the exercise of literate abilities. Finally, we have begun to build and field test a multimedia data base—a computer-based compendium of video from the factory floors; audio-taped interviews with line workers, engineers, and managers; examples of written documents and schematic diagrams and other data—which can be used to introduce vocational and literacy educators, in dynamic fashion, to the literacy requirements of changing workplaces. This project was co-sponsored by the National Center for Research in Vocational Education and the National Center for the Study of Writing and Literacy.

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CHANGING WORK, CHANGING LITERACY?
A STUDY OF SKILL REQUIREMENTS AND DEVELOPMENT IN A TRADITIONAL AND RESTRUCTURED WORKPLACE

INTRODUCTION

All about us, as we prepare this report on our study of literacy and work, the world of work is changing. Each day factories move across national borders, companies restructure in an effort to improve their competitiveness, and workers are told they must acquire and demonstrate more and different skills. We are witnessing the demise of the high-paying, long-term, union-backed, relatively low-skilled manufacturing job and the rapid spread of work that often doesn't pay much, that is temporary, that rarely offers the benefits that North Americans have come to view as entitlements. Trade treaties such as NAFTA are passed, amidst great controversy as well as fanfare, and promises are made that displaced US workers should be, will be retrained, retooled, reemployed. Almost everyone is affected in some way by these great shifts, and almost all are uneasy.

It is in this highly charged atmosphere that we began three years ago a study of literacy in the context of work. We wanted, by documenting the writing, reading, and communication activities that characterize changing workplaces, to shed helpful light on what workers need to know in order to obtain jobs and to promote. As we will argue below, understanding the role of literacy in work requires understanding work—what its processes are, how it is structured, how it is influenced by industry standards and history and by international trends and pressures. Thus, we designed our study to allow us to examine literacy in situ, as it occurs within and obtains its significance through events in the workplace. Conversely, we have used our understandings of language, literacy, and learning to focus our inquiry. Although we have examined the process of work as a whole, we have focused particularly on activities which foreground literacy, language, and skill requirements, such as the production and use of documentation, cross-cultural and cross-position communication and problem solving, and opportunities to learn on the job.

Throughout our studies we have been fortunate to have occasions to speak with workers about their educational and work histories and their hopes and plans for the future. Although there are many accounts of changing work settings from the perspectives of corporate leaders, political figures, and policy analysts, rarely do we hear from or about everyday workers—except the extent to which they are perceived as unskilled or inappropriate for the jobs now available. We think it especially important, then, to report the experiences of people on the front lines of widespread economic and structural change in the workplace and to learn what we can about their ways of coping with and rising to the very great challenges of making a living these days, including meeting the ever-increasing skill requirements. Thus, our descriptions and analyses of literacy at work are interwoven with narratives of workers' lives.

Background to the Project

In recent years worry about literacy in the United States has escalated, with new concerns being voiced about workers' skills (see Hull, 1991b). While national reports in the 1980's (*A Nation at Risk*, 1983; Carnegie Task Force, 1986; Holmes Group, 1986) called attention to the ways in which school children were performing poorly at reading, writing, and math, the current decade has extended this concern to adults, linking perceived deficiencies in workers' "basic" and "higher order" skills to lowered productivity and a lack of competitiveness in the international marketplace (*The Bottom Line*, 1988, Carnevale, Gainer & Meltzer, 1988; Lund & McGuire, 1990). The claim is that, in order to be competitive, American industries must adopt new technologies and new forms of work organization often labeled "high performance," in contrast to more traditional, Tayloristic models (*America's Choice*, 1990; SCANS, 1992; see also Sarmiento & Kay, 1990). The demand is that schools support these changes by teaching the knowledge and skills thought to be needed in restructured, technologically sophisticated workplaces (SCANS, 1992).

Although definitions of what actually constitutes a "high performance" workplace vary, it is usually assumed that such workplaces require greater collaboration and communication, provide opportunities for the exercise of different and more complex skills and literacies, and give front-line workers more responsibility (*America's Choice*, 1990; SCANS, 1992; Sarmiento & Kay, 1990). In addition, it is claimed that companies aiming to become "high performance" will need to make larger investments in training and offer higher salaries for the payoff of increased productivity (*America's Choice*, 1990; Carnevale, Gainer & Meltzer, 1990). In this atmosphere of change, many fear that American workers—increasingly "nonmale, nonwhite, and nonyoung" (Ehrlich & Garland, 1988)— are poorly trained and poorly skilled, and therefore ill-equipped to cope with new workplace demands (see also *The Bottom Line*, 1988; Carnevale, Gainer & Meltzer, 1990).

Despite such claims about the skills, including the literacies, required in reorganized, technologically sophisticated workplaces, as well as what skills many workers lack, little is known about the actual skill demands of these workplaces or the kinds of training new jobs might require. In fact, most of the complaints about worker "illiteracy" arise, not from detailed observations of work, but from surveys and anecdotal reports which rely largely on the perspectives of managers (Baba, 1991; Darrah, 1990, 1991). It isn't clear, then, just what literate capabilities are required in work or even what literate capabilities workers possess or lack—although such information would seem to be crucial for reconceptualizing secondary and post-secondary schooling, vocational training, and workplace education efforts.

Comparable gaps exist in what we know about "high performance" workplaces. Because of fierce competition in world and domestic markets, there has been, since the 1970's, an increasing incentive for US manufacturing firms to adopt "high performance" or "transformed" work systems as an alternative to mass production. Mass production is no longer considered a viable work system in the US partly because newly industrialized countries are able to offer lower wages, and thereby compete favorably with industries in the US, and partly because, with microprocessor technology, it is increasingly possible to customize and diversify products, which doesn't lend itself to mass-production processes. Appelbaum and Batt (1993) point out that, in looking for alternative work systems to mass production, US firms have been influenced by "high performance" models from several other countries, such as Japan's popular notion of "lean production" or Sweden's innovations with autonomous work teams. Ideas have also been gleaned from what is called the American "human resource model," as developed in earlier decades at IBM and Hewlett Packard. Surveys indicate that a majority of large firms have adopted some innovative practices associated with "high performance" models. But these borrowings, according to Appelbaum and Batt (1993), have been piecemeal, and they tend to affect only a minority of employees. Moreover, the research that has been done on companies which have adopted innovative work practices is extremely limited, being based largely on non-representative surveys that are often marred by various sources of bias, and on case studies based on interviews with managers and brief tours of workplaces. Appelbaum and Batt (1993) point out that such cases rarely attempt to represent the workplace from the point of view of front-line workers or include detailed observations of work.

Among the common features of alternative production models that Appelbaum and Batt (1993) identify are the following: (1) flexible technologies; (2) some worker participation or teamwork; (3) substantial worker education and training; (4) flexible deployment of workers; (5) commitment to employment security; (6) a smaller gap between workers and managers (in terms of education levels, managerial decision making, and wages); and (7) an active role for unions in achieving performance gains. (See also Brown, Reich, and Stern, 1993; Jorgeson, 1988; Lawler, 1992; *American's Choice*, 1990.) These features may be referred to in a variety of ways by different companies, and the same term, such as "quality circles," often has a different meaning in different companies and perhaps even in different contexts within a single company. Thus, among the challenges facing those who would understand changing work environments is determining exactly what features from alternative production models companies have adopted, how those features are implemented in practice, who these practices have affected, and the kinds of skills associated with the new practices.

Thus, we proposed a research project that would fill in some of these gaps. Specifically, we offered to:

- develop a methodology for investigating literate activities in workplace settings;
- document the actual demands for different literacies in changing work environments—settings in which work is being reorganized and new technology is being introduced—with an eye toward broadening current conceptions of literacy;
- provide information to the secondary, post-secondary, and vocational education communities about the changing literacy demands of workplaces; and
- make recommendations about the kinds of literacy education and training that seem most useful in helping workers adjust to future, more technologically complex work environments.

The project we proposed differed from most research on literacy and work both in its view of literacy and in its methodology. One common approach to studying reading and work has been the attempt to determine the "reading difficulty level" of job-related materials through the application of readability formulas (cf. Diehl & Mikulecky, 1980; Duffy, 1985; Mikulecky, 1982; Rush, Moe & Storlie, 1986). These formulas use text features such as word and sentence length to estimate the grade level in school in which equivalent texts would be found, and thus have been useful in calling attention to the amount of reading done at work, and as very broad descriptors of the level of difficulty of these texts. The problem with this research, as even those who have conducted it have pointed out (cf. Sticht, 1988), is that it treats reading as a decontextualized, unitary process, and also that it transposes notions of reading in schools to the workplace, without taking into account the differences between school and work contexts and between child and adult readers.

A second approach has sought to create a new category of literacy, similar to functional literacy (cf. Kirsch & Jungeblut, 1988; Sticht, 1988; for a critique see deCastell & Luke, 1983), called "occupational literacy" (Rush, Moe & Storlie, 1986). Challenging the view that school reading is the same as reading at work, this line of research has sought to distinguish the functions of reading at work compared to those at school. Building on Sticht's studies in the military (Sticht, 1979; Sticht, Armstrong, Hickey & Caylor, 1987; Sticht & Hickey, 1987), researchers have surveyed employers and assessed employees in a wide range of occupations, in an attempt to determine the literacy demands of work (e.g., Diehl & Mikulecky, 1980). The findings of this research included the observations that most jobs required about two hours of reading, that people were able to read more difficult material than their assessed reading levels, and that reading at work is used for different purposes than those typically emphasized in schools (see also Mikulecky, 1982; Sticht, 1988; Sticht & Hickey, 1987; Rush, Moe & Storlie, 1986). Such work has thus offered us a more complex and contextually-based view of literacy and work, focusing attention on the ways in which workers use texts differently than children are taught to in school. It has also spurred the development of "functional context" curricula, the dominant paradigm currently guiding the development of workplace literacy programs (see the discussion by Gowen, 1990). Yet, we believe that much of this research defines context too narrowly—actually as the "texts" that are found at work (Grubb, Kalman, Castellano, Brown & Bradby, 1991)—and thereby misses what can be learned from fine-grained studies of literacy that take into account the broader context of the social organization of work.

While the work of Sticht and others who built upon his findings could be said to take a cognitive approach to investigating reading on the job, a socio-cognitive theory of learning provides a third way of investigating literacy and work. Scribner and her colleagues (Jacob, 1986; Martin & Scribner, 1988; Scribner, 1985, 1987; Scribner & Sachs, 1991) have for a number of years been interested in understanding knowledge acquisition, particularly the relationship between knowing and doing in culturally organized human activities. Most recently, they have carried out their studies in an electronics plant, a factory where tools were once hand-tooled but are now produced through computer-aided-design, and a dairy. In the last context, Scribner and Jacob (Jacob, 1986; Scribner, 1985, 1987) focused in part on literacy, uncovering not only unexpected functions and uses of reading and writing but documenting as well the social networks that support literacy practices (cf. Reder, 1987; Fingeret, 1983; Heath, 1983). In this research, then, "context" is defined as the immediate work environment, which includes not only the texts that workers read and write, but also the social relationships and activities that guide and influence the use of texts.

The notion of literacy as embedded in practices has furthered our understanding of how to study literacy. However, current literacy theory broadens the notion of context even more, suggesting that literacy learning must be understood as part of the larger historical, social, and cultural milieux. It is this theory that we believe provides the best foundation for studying literacy at work. Literacy can most accurately be described as a set of socio-cultural and cognitive processes, varying within and across groups of people and settings (Cook-Gumperz, 1986; Freedman, Dyson, Flower & Chafe, 1987; Scribner & Cole, 1981; Street, 1984). Rather than as a set of decontextualized skills, literacy can be viewed as a range of practices specific to groups and individuals of different cultures, races, classes and genders.

This reconceptualization changes the way we look at literacy at work, shifting attention from readability studies of work-related materials and toward fine-grain studies of work practices that include an examination of the historical, social, and cultural factors that influence work, workplaces, and workers. The great difference in these approaches is apparent if one compares the kind of information that can be gained from analyzing a manual or memo in isolation—counting its words to estimate its difficulty, for example—to the kind of information that can be gained from examining the production and use of this document in the social systems of the workplace, including historical precedents and cultural contexts.

While a cognitive and socio-cultural perspective has been used to study literacy at school and in communities (for a review, see Dyson & Freedman, 1990), we know of no studies which have taken this perspective in order to examine literacy at work.[1] As workplaces become more diversified, drawing upon ethnically diverse populations (*The Bottom Line*, 1988; Carnevale, Gainer & Meltzer, 1988; Ehrlich & Garland, 1988); as work is reorganized, giving workers more responsibilities (*America's Choice*, 1990; SCANS, 1992; Sarmiento & Kay, 1990); and as work becomes more technologically sophisticated, requiring workers to draw upon "intellective" in addition to "sentient" knowledge (Zuboff, 1988; Martin & Scribner, 1988; Martin & Beach, 1990), new work practices and thus new literacies are likely to emerge. A socio-cultural and cognitive perspective is needed in order to best understand literacy in these increasingly complex workplaces (cf. Erickson, 1984, 1992; Baba, 1991). In the project reported here we adopted such a perspective in order to study the literacy demands of two workplaces in a single industry.

The Project

To foreground the changing skill requirements that are believed to be associated with "high performance" workplaces, we hoped to study a workplace that was in the process of restructuring its organization and that identified itself as becoming "high performance." In particular, we wanted to identify a "high performance" workplace that was attempting to shift responsibilities and authority from supervisors and managers to front-line workers and which intended to require more of those workers, especially in terms of problem solving, teamwork, and personal and collective initiative. For purposes of comparison, and also because most workplaces continue to adhere to traditional forms of work organization, we also studied one workplace which has not undergone recent changes in these directions. For the comparison to work, both of these workplaces had to represent the same part of the same industry. We want to emphasize that although we studied only two workplaces in fine-grain detail, we chose these workplaces strategically, as representatives of two kinds of work organization, in order to widen the applicability of and interest in our findings. As an additional selection criteria, we identified workplaces which provide entry-level positions for non-college-educated applicants. This population is frequently targeted as underprepared and ill-equipped for the changing job market.

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[1] There are studies of skills in the workplace that take an ethnographic perspective. For a review of these see Baba, 1991. See also Darrah (1990, 1991). However, these studies don't focus on literacy in particular. Studies of writing in the workplace are rarer still (for exceptions see Odell & Goswami, 1982; Mikulecky & Winchester, 1983).

Research Questions

For each set of the following research questions, we compared and contrasted the traditional and "high performance" workplaces:

1- How is work organized, and what role does literacy play in how work gets done?

2- What are the literacies required in the workplace? As workplaces undergo change—both in their organization and through the addition of technology—what is the effect on the literacy demands of the work?

3- What are the characteristics of the current workers in these workplaces in terms of their school histories, training, and work experience? What are the characteristics of the new workers these companies are looking to hire?

4- What are the literacy requirements for entry-level employment in these workplaces? What are the criteria for advancement within the workplace? Are these criteria changing as the work changes?

5- What kinds of training or education are provided by the workplace? What definitions of literacy are implicit in the instruction?

Methodology

Ethnographic Approach. Using a cognitive and socio-cultural perspective to understand literacy at work, we conducted empirical studies based on how work is accomplished over time. For the company ~~which is~~ undergoing a transition to a "high performance" workplace, we documented changes in literacy and skill requirements and actual use, as the work changes. For the company which adheres to traditional forms of work organization, we documented the literacy skills and requirements that are in place. Rather than relying upon "grand tours" of the workplace, which can result in a limited and distorted view of both workers' and managers' roles and activities (Darrah, 1990; Spradley & McCurdy, 1972), we used ethnographic methods which allowed us to investigate, in close detail, the perspectives and understandings of the various stakeholders in the two workplaces. By collecting recurrent instances of events across a wide range of activities within each of the workplaces and through conducting extensive interviews, we were able to determine the full range of variation in both the social organization of the workplaces and the perspectives of the workers and supervisors (Erickson, 1986). From the information collected, we generated and tested assertions through a systematic search of the data base, seeking confirming and disconfirming evidence and looking for key linkages among the various items of data (Bogdan & Biklen, 1982).

Data Collection. The field work included (1) systematic observation in the workplaces and the communities where those workplaces are located; (2) participation in the actual work whenever possible by "shadowing" workers or working alongside them; (3) interviews with employees at all levels about their work, the role of literacy in that work, and their educational and work histories; (4) observation of and/or participation in any training that is offered through or required by the workplace; (5) the collection of pertinent documents. Observations and interviews were recorded in detailed field notes. We also audio-taped almost all interviews and, and more rarely, video-taped events in the workplace which demonstrated the skills and literacies that people employ as they conduct their work and participate in training. In addition to this work in the field, we researched the history and development of the industry, including the role of technology in it over time, the industry's responses to increased international competition, its policies regarding credentials and retraining, its relationship to the community. This information allowed us to understand current policies in their historical context.

As our field work progressed and we gained more knowledge about the nature of the work and the worker culture, we conducted periodic informal interviews with workers and supervisors to confirm, disconfirm and augment our observations. We had hoped, in fact, to engage workers and managers in helping to refine our research questions and in collecting data to address those questions (cf. Lather, 1991; Lytle & Schultz, 1992), but in actuality this occurred only rarely. In the workplaces that we studied, work was intense, and these conditions left them little time or energy during the work day for reflections on our research.

Nonetheless, our roles in the factories went beyond the usual notions of "participant observation," and criss-crossed the boundaries traditionally (and artificially) set between researcher and researched. We frequently provided some personal assistance to individuals. Since many workers were recent immigrants whose English was shaky, we offered ourselves, and were regularly relied upon, as language intermediaries. Once a worker who moonlighted in a Chinese restaurant brought us the menu so that we could record the English pronunciation of "pot stickers" and "vegetable fried rice." We intervened on many occasions for a young supervisor, an ethnic Chinese who grew up in Vietnam but had developed an American penchant for credit cards and mail order houses. Her query of "what is sweepstake?" began a month's long saga of negotiations with a disreputable mail order house to return $899.00 worth of pens. We read and commented upon essays from night school, we interpreted traffic tickets and insurance policies, we ventured opinions regarding medical options, and we exchanged business cards with anxious parents happy to know professors from the university where their sons and daughters were enrolled or had aspirations of attending.

Our roles as language and cultural brokers helped people to trust us, people from whom we were separated by vast cultural and social gulfs. We became their friends as they became our informants, and these relationships helped us immeasurably as we attempted to understand work activities and social positions on the shop floor. In the same way, then, that a factory can helpfully be understood as the product of multiple influences—its industry, its local history, the current economic climate, the vision of its managers—so can the attitudes, abilities, and actions of workers be usefully interpreted in light of their work and educational backgrounds, their individual styles and creativities, their cultures and genders.

Data Analysis. Because of the nature of our research, data analysis recurred throughout the project. To be sure, our more formal analyses intensified when data collection ended, but throughout the project we developed, discussed, and tested hypotheses about what we were seeing. In line with the cognitive and socio-cultural perspective with guides our research, the goal of our analysis was to construct a holistic picture of the workplace, including a description of the socio-cognitive nature of the work and particularly the role of literacy within it and the way that work is embedded within a socio-cultural work setting and organizational history.

To organize our qualitative data, we relied on three units of analysis. Two of these—meetings and training sessions or classes—have familiar and easily recognized boundaries, and have been studied in a variety of educational and corporate settings. But to analyze the process of process of work, we developed a unit of analysis that we called a "work event." This unit of analysis builds on Heath's (1982; cf. Anderson, Teale, & Estrada, 1980) construct of a "literacy event," or all the interactions and activities surrounding the use of print for a particular purpose in a particular situation. Because we wanted to understand literacy in the context of work, and to let this context shape our understanding of literacy, we felt that the notion of a "literacy event," while useful, was too constraining. Instead, we began to focus on the interactions and activities which contribute to accomplishing a task or goal in a workplace, and from there we recognized the importance of moments (especially in the particular industry we were studying) when the smooth flow of work is interrupted and problems have to be solved to set it in motion again. Such a moment, and the texts and social interactions that comprise it, along with the rules and strategies that govern those interactions, is what we call a "work event." The event may last only a few minutes or may extend over a period of days, weeks, or months, depending on the nature of the problem. And such events, we have found, typically have a literacy component.

To analyze work events, team meetings, and training sessions or classes, we drew on a variety of methodological tools:

(1) *Seeking patterns of thought and behavior.* Using what is perhaps the most basic of all qualitative analyses, we looked for patterns of thought and behavior (Bogdan & Biklen, 1982). We systematically sorted and reflected on the information collected from various sources—observations, interviews, documents, field notes. As patterns emerged, we sought confirming and disconfirming evidence, interviewing the supervisors again with more precise questions, or interviewing other workers to determine whether the pattern holds for them. We also consulted with participants, testing our hypotheses against their sense of things. As we have described it here, this process probably appears linear, with the analysis of one pattern following another. However, in practice we found that we work on several patterns simultaneously (cf. Fetterman, 1989), as our

understandings grew progressively more complex and as we moved closer to the final goal of creating an account in which patterns contribute to a coherent interpretation of the whole.

(2) *Key events*. In the course of observations and participation in the workplace, and through consultation with key informants, we were alert to activities, moments, or situations which carried unusual weight, which could illustrate or symbolize, for example, important tensions or problems, typical ways of negotiating change, or habitual ways of thinking and acting (cf. Fetterman, 1989; Geertz, 1957). The interactions and practices which surround and comprise such key events can be an extraordinarily rich source of data and can direct and focus one's analysis. One obvious key event in a workplace is the introduction of a new technology; another might be particular "team" meetings, in which new ways of organizing work are introduced; another still could be the induction of a new employee into management and worker culture. Once identified, these key events can be analyzed using multiple methods, such as analyses of patterns (described above) or conversational analysis (described below).

(3) *Conversational analysis*. In order to more precisely determine speakers' intentions, on occasion we analyzed the stresses, tones, pauses, and inflections of speech that we recorded on audio- or video-tape during interviews and observations (e.g., Gumperz, 1992; Hull, Rose, Fraser, & Castellano, 1991). Such an analysis allows one to interpret talk more confidently, and it is also an empirical demonstration of how conversation can go awry in inter-ethnic or inter-status exchanges, such as those which might occur as a matter of course in a multi-cultural workplace (cf. Cook-Gumperz, 1986). We also used this method of analysis as a check on our own influence on the interviews that we conducted. But because the method is very labor-intensive, we used it sparingly, focusing particularly on the conversations which surrounded and comprised key events (see above).

(4) *Narrative analysis*. As mentioned earlier, we planned to interview workers about their educational and work histories, for we have found in previous research (Hull, 1991) that such interviews are a rich source of information about the paths people follow or create as they navigate the institutions of schooling and work. One way to analyze such "life histories" is simply to mine them for a chronology—the ins and outs of individuals lives and careers. But it is also possible, and we would argue important, to

analyze them also as stories, as constructed accounts, and to understand how such accounts are influenced by the context of the interview. For these perspectives, we relied on the suggestions of Mishler (1986).

(5) *Socio-cognitive analyses of work events*. Ethnographic approaches do not always include fine-grain analyses of cognitive events such as reading, writing, or problem solving (cf. Erickson, 1984), but if we are to take a cognitive and socio-cultural perspective, then a close look at how people accomplish particular "intellective" and/or "sentient" tasks (Zuboff, 1988) is required. Thus, for some units of analysis, we attempted to identify the rules and strategies that people drew upon in carrying out their activities, and also to trace the sources of the rules and strategies, as far as was possible, to workers' previous education, training, and experience on the job (cf. Hull & Rose, 1989; Scribner & Sachs, 1991; Sachs, n.d.).

(6) *Socio-cultural and historical analyses of work*. In our previous work on literacy (e.g., Hull, Rose, Fraser, & Castellano, 1991), we conducted socio-cultural and historical analyses in order to understand literacy practices in the particular classrooms. That is, we looked to history for antecedents for contemporary problems, and we also situated our analyses of current problems in socio-cultural understandings of race, gender, and class. These same perspectives informed our analyses of work and the roles of literacies within it. Although we were not able to conduct analyses that lead to comprehensive understandings of an industry, such as Shaiken's (1984) treatment of machining and Lamphere's (1987) studies of the textile industry, we were able, through an examination of historical documents and through focused interviews with people within and outside the workplace, to inform our socio-cognitive analyses of work events (described above) with a broader, socio-cultural understanding of how an industry has developed in general in the United States and in particular in a given region.

Analytic memoranda. In the course of our analyses, we regularly produce a variety of intermediate products or memoranda. These memoranda served several functions: (1) as data for other analyses, such as the analysis of patterns or analysis of the socio-cultural and historical contexts; (2) as foci for checking our observations, hypotheses, and conclusions with workers and managers; and (3) as ends in themselves—pieces of our final report (cf. Fetterman, 1989). Our analytic memoranda included, most importantly, taxonomies of the functions that literacy served in meetings, training, and on the shop floor. These taxonomies will be featured prominently in the analyses that we present in this report and are included as appendices. In addition, we developed related taxonomies for work activities and classroom activities. Other memoranda featured educational and work histories of individual employees and narratives of work events, training sessions, and team meetings.

In summary, this project brought to bear recent cognitive and socio-cultural understandings of literacy in an investigation of the skills required in a newly organizing and a traditionally organized workplace. In so doing we developed a methodology for studying literacy at work, one which draws upon cognitive, socio-cultural, and historical perspectives. An overview of how particular methods were used to answer particular research questions is provided in Table 1.

Table 1: Relating Research Questions to Methods of Data Collection & Analysis

RESEARCH QUESTIONS (pp. 7-8)	DATA COLLECTION PROCEDURES (pp. 9-10)	DATA ANALYSIS (pp. 10-13)	ANALYTIC MEMORANDA (pp. 13-14)
1. Organization of work, role of literacy	1. Interviews, observations, documents	1. Patterns, key events, socio-cognitive	1. Narratives of work events, training sessions, team meetings; literacy taxonomy, work taxonomy
2. Changing literacies at work	2. Interviews, observations, documents, participation in training	2. Patterns, key events, socio-cognitive, socio-cultural and historical	2. Literacy taxonomy, narratives of work events, training sessions, team meetings
3. Worker characteristics	3. Interviews, documents, observations	3. Patterns, key events, socio-cognitive, socio-cultural and historical	3. Educational and work histories, literacy taxonomy, work taxonomy, class taxonomy
4. Literacy requirements	4. Interviews, documents, observations	4. Patterns, key events, socio-cognitive, socio-cultural and historical, and conversational analysis	4. Literacy taxonomy, class taxonomy
5. Training and education	5. Observation, participation	5. Patterns, key events, socio-cognitive	5. Class taxonomy, literacy taxonomy

Development Efforts

One question that often plagues researchers is how to make their work accessible, interesting, and useful to a wide range of lay people or non-specialists, who might include educators, policy-makers, leaders in business, industry, and labor, as well as the general public. In previous research (Hull, Rose, Greenleaf, & Reilly, 1991; Reilly, Hull, & Greenleaf, 1992; Greenleaf, Hull, & Reilly, 1994), we have found it effective to make our qualitative data available to educators for their own analysis, reflection, and interpretation. Thus, in addition to writing research reports and journal articles about our work, we have constructed print- and computer-based materials which present qualitative data—for example, segments from interviews, samples of texts, excerpts of classroom talk—and which ask teachers to construct their own accounts of the teaching and learning represented by the data. This strategy is based on the view that educators are rational, "problem-solving professionals, who apply beliefs, theories, and knowledge to their work" (Schön, 1989), and it draws as well upon the "case method," which increasingly popular in both business and teacher education (e.g., Schulman, 1990).

In our current work we are doing something similar: We are developing an interactive multimedia data base in which we present data from our field research in the form of texts and documents, photographs, audio, and video. In so doing, we aim to introduce educators to the complex contextual circumstance in which workers engage in literate behavior within the factories we have studied, and to help them discover how literacy occurs and obtains its significance through events within the workplace and how literacy and its requisite skills are inexorably linked with a social-cultural-historical context. The multimedia format is particularly important for this project on the workplace, for factories and the literacy-related work that takes place in them aren't easily visualized.

In Appendix A we describe the data base in more detail. It isn't, at this writing, complete, but we hope to finish it during 1996, and we outline our plans in the Appendix. We turn next to a description of the industry we studied and the individual factories.

Background: From Orchards to Electronics

Riding South on Interstate 80 from Oakland, CA, toward San Juan, the temperature and the scenery change. The deeper one goes into the Santa Clara Valley and the farther away from the San Francisco Bay, the hotter and sunnier it gets. And although the Diablo Mountain Range is always in view in the distance, the immediate landscape is quickly dominated by miles and miles of the sprawl of one-story, modern, prosperous, cheerful- looking stucco buildings with names recognizable to those in the know in the computer industry: Intel, Sun, Flextronics, Hewlett-Packard, Lexitron, Apple, Silicon Graphics. This is the Silicon Valley, and although one can find examples of industries other than electronics here, this twenty-five mile strip of the San Francisco peninsula belongs to the design and manufacture of computer boards, chips, and components. It is hard to believe that all these miles of buildings and parking lots with some 2000 high-tech companies were, as late as the 1940's, orchards of apricots and walnuts.

The Silicon Valley of Northern California is often held up as a major economic success story in the United States. As is widely known, in the 1980's this country's manufacturing base down-sized dramatically and also moved many of its operations overseas, putting working people in the US who had been accustomed to decent pay way above the minimum wage out of work, leaving those who kept their jobs accountable for more, and bolstering its profit margin from the lower wages offered to workers in other countries. The trend has continued in the 1990's, accompanied recently by the mandated shrinkage of the US military machine and the closure of military bases across the country, with California being especially hard hit. In the midst of the turmoil and economic disarray created by these massive changes, the Silicon Valley has stood apart, growing steadily, even booming in the 80's, keeping a significant proportion of its manufacturing at home, and even defeating at last count a Japanese challenge in chip production—and this despite a statewide exodus of manufacturers who refused to cope with the state's environmental regulations and comparatively higher taxes and wages. It is no surprise, then, that companies in the Silicon Valley regularly play host to foreign dignitaries and US political figures who come to pay homage at this outpost of economic ingenuity.

This is not to say that the Valley hasn't experienced a share of economic difficulty. Almost totally dependent on the electronics industry, the area feels any drop in electronics sales or related economic downturns acutely. In the early 1990's, for example, many computer-related companies announced salary cuts, layoffs, and plant closings, including the largest layoff in Apple Computer's history. Other high-tech firms similarly down-sized or moved their production facilities to other, less expensive areas of the state, and some left the state entirely. There have been investigations of and penalties for toxic leaks and air pollution. The jury is still out, then, as to how the Valley will weather the most recent economic turbulence, but early signs, such as a boom in the sales of multi-media electronics gear, the expanding infrastructure of the "information super-highway," and the rapid expansion of the individual factories we personally have studied, suggest that the Silicon Valley will likely continue its economic wizardry.

There are various explanations for the Valley's development and its success, including the availability of intellectual resources and support at local colleges and universities as well as access to ready capital, including billions from the US federal government supplied for research and development. But most accounts also acknowledge the role played by young entrepreneurs who plied their considerable technical know-how and sharp business sense into multi-million dollar enterprises. These young entrepreneurs are said to have constructed, and been influenced by, a unique local industrial environment, where fierce competition operated within a collegial atmosphere of inter-firm cooperation and networking. Annalee Saxenian (1994), who has analyzed the nature of this environment and assessed the ways it has provided regional advantage in the US, describes the Valley as a "network-based industrial system that promotes collective learning and flexible adjustment." Despite intense inter-firm competition, she argues, companies also learn informally from each other, communicating and collaborating as the need arises. Saxenian sees much to praise in these "loosely linked team structures [which] encourage horizontal communication among firm divisions and with outside suppliers and customers" (pp. 2-3).

What we would point out about this characterization is its unit of analysis, which is the company within a region. Saxenian's argument, like those of most researchers who attempt to explain the Valley's structure and success, appropriately focuses on the strategies adopted by young entrepreneurs and their roundtables of engineers to foster innovation within their companies and competitive, though comradly advantage outside them. What is missing from this picture is the front-line worker. It is important to note, we think, that conversations about the success and development of the Valley (and other regions in the US and beyond) can and do take place with scant reference to eighty percent of its workforce, the men and women who manufacture silicon chips and assemble circuit boards, the people who do the actual work of production. Implicit here is the extreme segmentation of the Valley workforce into highly skilled technical and professional workers at the top, and the much more numerous production worker, often recent immigrants from Asia and Latin America who don't earn a lot more than the minimum wage and for whom opportunities to advance are few.

The project reported here, in contrast to most of the available literature, takes as its primary focus Silicon Valley production workers. That is, we attempt to situate the success of the Valley and its entrepreneurs within an account of the working lives of front-line employees from two electronics factories. These factories perform contract work for big-name electronics companies such as Intel, Apple, and Silicon Graphics, but are also well-known in the Valley in their own right as fast growing and successful.

More Background: Contract Manufacturing

It's often noted that the most prevalent job in recent years is the temporary one, a trend which provides workers no job security and few benefits like health insurance, but enables corporations to adjust their labor overhead to the ebb and flow of the market. Indeed, the largest employer in the United States is Manpower, Inc., a temporary agency. A parallel and complementary phenomenon to temporary hiring is contract manufacturing, also called "out-sourcing," and in fact, contract manufacturers depend heavily on temporary workers. Contract manufacturers perform services for other companies, central services that were once performed by the companies themselves. For example, while big computer companies like Apple and IBM used to assemble all their own circuit boards in house for their own products, it is now customary to farm out this aspect of their production.

Early on, during the 1960's, Silicon Valley firms drew on contract manufacturers to assemble their boards mainly in peak periods when demand was too great for the companies to handle themselves. These contract manufacturing houses were called "board stuffers"; small, marginal firms, they paid immigrant workers, often women, very low wages to attach components to boards by hand. Workers labored in sweat-shops or took the work home. The components and materials were provided by the customer along with design instructions and directions for assembly. In essence, all the contract manufacturers provided was bodies. There are still board stuffing houses in the Valley, although many of these shops have moved to Asia and Latin America where wages are even cheaper.

Contract manufacturing in circuit board assembly has changed a lot since the heyday of board-stuffing. In the 1980's big companies like Sun, IBM, and Hewlett-Packard started to rely on contract manufacturers to do more of their work so that they could further reduce their costs, have a quicker turn-around time for their products, or focus themselves on other aspects of manufacturing, such as product development. Simultaneously, and also as a result of an increase in business, circuit board companies began to invest in expensive new technologies, in particular, robot-controlled surface-mounting techniques. In the past, boards had been assembled mainly by hand using what is called "through-hole" technology: That is, workers soldered individual leads from an integrated circuit through the holes in the boards. Surface-mounting techniques, on the other hand, use epoxy or solder paste to attach tiny electronic components onto both sides of the boards. This technology is much more complicated and capital-intensive than through-hole. It is described as five to ten times harder a process, and just one line of surface-mount robots costs over a million dollars.

Computer firms were happy to let contract manufacturers invest in this costly technology (contractors could turn a profit despite the required investments in technology given their high volume) and to gradually turn over more and more of their assembly work. As the companies developed relationships over time and built up trust with each other, the firms began to depend on contract houses for more sophisticated services, such as board design and testing, as well as the procurement of components. And thus, the shape and significance of contract manufacturing has changed radically over the years.

The dark side of this development is that, by relying on contractors, electronics companies no longer have to make commitments to a significant portion of their former workforce for job security or health plans or decent wages (Siegel, 1993). It is customary among those circuit board assembly plants in the Valley to rely heavily on a temporary workforce. Wages are low—from six to ten dollars an hour—and lay-offs and enforced overtime, depending on the vagaries of customer demand, are the norm. None of these Silicon Valley factories are unionized.

Being a contract manufacturer has particular implications for doing business, and as we shall see, ramifications as well for the skills its workforce is called upon to develop and use, especially literacy. A company chooses one contract manufacturer over another because of lower costs, high quality, and productivity, so there is much ado in these companies about minimizing defects and speeding up production. Because technology changes so quickly these days, a contract manufacturer's customers can be expected to be particularly demanding, calling for changes in boards that are already in production and regularly returning old boards to be re-worked and updated on short notice. Record-keeping on these occasions is paramount; customers want to know what changes were made on which boards on what dates and by whom. Paper trails are thick. Customers also want to be assured of a certain level of competence before they bring their business, and thus, circuit board assemblers, like a growing number of other US and European firms, vie to be certified by international standards agencies (cf. *Fortune Magazine*, June 28, 1993). These agencies enforce stringent procedures concerning documentation, so that factories are practically afloat in a sea of paper. It is customary for every single procedure that takes place within such a certified factory to be written down, documented, and workers' activities, their work practices, are expected to match the printed account and are regularly audited to ensure that they do so.

This history of the Valley and contract manufacturing raises many questions when we consider it in light of recent attempts to build high-performance work organizations. For example, given that most production workers in the Valley are poorly compensated and over-worked now, how will they respond to requirements that they develop new work practices that depend on the development of new work-related skills, such as collaboration, goal-setting, and literacy? How will they greet increased work demands, such as perpetual training, reams of required documentation and data analysis, and ever spiraling quality and productivity goals? How will managers and supervisors, many of whom are white and all of whom necessarily deal with a multi-cultural, multi-lingual workforce, respond to their charge to create a new work "culture"? How will they envision instruction and training, what attitudes do they bring to the table about their employees' abilities and motivations, and how will they manage changes in their own responsibilities, some of which they will be expected to "hand-off" to front-line workforce? In sum, in these changing situations, what new social identities will people construct?

A TALE OF TWO FACTORIES: EMCO AND TEAMCO

This was a comparative project, its major goal being to understand the literacy requirements of "high performance" workplaces versus traditionally organized ones. Toward that end, we studied in ethnographic detail two workplaces which represented this dichotomy. As we will discuss in a later section, the dichotomy is in important ways a false one, for a company can at one and the same time embrace features of high performance work organizations *and* traditionally organized ones. To further complicate matters, companies sometimes "talk the talk" but don't "walk the walk." That is, they claim to follow the high performance model but in actuality rely on quite traditional practices. Nonetheless, we were eventually able to identify two circuit board assembly companies, one of which we could classify as "traditionally organized," and the other of which was attempting, in grand scale, to move toward features of high performance work organizations, in particular self-directed work teams for all front-line employees. The traditional factory we call "EMCO," for "electronics manufacturing company." The other we named "Teamco," a pseudonym which highlights this company's recent investment in teams.

What is remarkable and fortunate about our choice of companies is that, aside from their policies and practices regarding work organization, EMCO and Teamco are very, very similar. In fact, although this was a violation of the companies' policies, we knew some front-line workers who were working simultaneously at both places, just on different shifts. Other employees—line workers, engineers, managers—had previously switched from one factory to the other, and continued to do so as our study progressed. This corporate version of musical chairs illustrates the interfirm permeability that researchers such as Saxenian (1994) have pointed out.

EMCO and Teamco are both quite successful, posting profits in the billions. They are both international, having plants not only in the Silicon Valley but in various countries worldwide. Indeed, they are both large, employing thousands of employees worldwide. They are both multi-cultural and multi-lingual, drawing on workforces comprised mostly of immigrants. This striking similarity means that our study wasn't an apples and oranges comparison, the juxtaposition of two essentially different work settings. Rather, the similarities made it possible for us to hone in with confidence on the differences in literacy requirements and practices that were associated with the factories' different perspectives on work organization and the roles and identities of front-line employees. We turn next to more detailed descriptions of EMCO and Teamco.

EMCO

A Fortune 500 company with annual revenues in excess of $1 billion, EMCO has worldwide employment of over 10,000 and approximately 350 workers at its Silicon Valley plant. The company is non-union (as are virtually all electronics firms in the Silicon Valley), and it represents "high end" manufacturing, focusing on high quality and the full range of services. EMCO carries out design, assembly, quality checks, testing, and packaging of circuit boards for diverse products, from helicopters to elevators to computers.

EMCO's front-line workers are mostly immigrants from Korea, Vietnam, and the Philippines—indeed, the factory used to be Korean-owned—while the current factory manager, his top management team, and their middle-level helpers are all white, native-born US citizens, as are most of the supervisors. The plant accepts entry-level employees, although most workers have experience in other Silicon Valley companies, and there are some—albeit very few—opportunities for advancement for the entry-level workers within the firm. The first step up from assembler or machine operator is the lead of a line or an area (although at EMCO, leads don't get a salary boost). Beyond leads are shift supervisors, and above supervisors in the hierarchy are engineers and a raft of mid-level managers. We heard of employees who had worked their way up to become supervisors and a few who had become engineers (without four-year degrees), but there the progression stops. Although supervisors and engineers interface with front-line workers on a daily basis, there is quite a gulf, as is customary in industrial America, between most of the workers and most of the management and, to a lesser extent, the engineers—one often exacerbated by differences in language, culture, and social class.

This factory is also replete with literacy; one might even say that it is in the stranglehold of literacy. Every single procedure that takes place within it must be written down, documented, and workers' activities, their work, practices must match the printed account and are regularly audited to ensure that they do. There is even a written procedure on how to write and revise a written procedure. This concern with documentation is largely the result of an international certification process known as ISO 9000, meant to ensure that companies meet certain industry-wide standards. Many companies in Europe go through the certification process, and it is fast catching on in the US. At EMCO some engineers and supervisors seem to flourish in this literacy-regulated environment, debating their documents' proper construction use and enforcing others' adherence to written procedures. Other workers, as we shall see, must find ways to circumvent what sometimes appears to be a tyranny of printed regulations.

We classified EMCO as a traditionally organized factory. However, it is important to note that its managers claim that it has adopted some of the practices associated with "high performance," such as self-directed work teams, decentralized decision-making, continuous improvement, and the use of flexible technologies. Here is how the plant manager talks about his efforts to make EMCO high performance:

> First you have to create a culture, where people believe that they can make decisions without being put in a penalty box. So that there is some freedom of decision making, and the staff that I got [when he first took the job as plant manager] was really afraid to make decisions, I got to tell ya. Now what happens is, in that environment, nobody makes a decision, because if they don't make a decision the folks beneath them are afraid to make a division, the people beneath them are afraid to make a decision, the people beneath them are afraid to make decisions. So the biggest challenge I had was getting the people to feel comfortable, that I wasn't in here to fire them. And that I was going to rely on them to start managing their area. ... So, the first thing I looked at was the culture, then the next was, you know, how do we do things so that everyone was aware of basic operating procedure of the plant. And, from that point, I started working on more of the power of it, and self-directed work teams.

This manager's emphasis on decentralizing decision-making is noteworthy. Of all the practices associated with high performance, those which "empower" employees by flattening hierarchies and creating cross-functional work teams where front-line workers have real authority are currently receiving the most attention. For this factory, it is important to note, then, that teams equal management; that is, hourly workers are not regularly included in team meetings, as the manager explains below:

> The only time we've had to have somebody from the factory really involved in [teams] is if we continue to have problems with efficiency or quality or whatever. But we get very high quality out of this plant and if I thought that we were continuing to have a real problem in the quality area I would probably get some of the direct labor involved in some sort of a team to start evaluating why we were having quality issues on the floor. Because I am sure that it could create some pressure on their co-workers to be more aware of what they should be doing to make the quality product.

But as will become apparent as our story proceeds, EMCO is much closer to traditional rather than high performance work organization, despite the fact that it has adopted high performance practices, especially self-directed work teams.

EMCO managers were generous in allowing us to study work processes in the entire plant, including the work of designers, engineers, and managers, as well as technicians, materials planners, machine operators, and through-hole assemblers. We observed work in almost all areas of the plant, including a variety of management team meetings, and at times shadowed workers or participated in work and training sessions. Particularly rich were our observations of work processes during second shift, when there were no managers and only one helpful supervisor present. We interviewed a variety of front-line workers, engineers, and managers about their educational and work histories.

These interviews were audio-taped, as were the sessions in which we observed people work or we participated in work and training sessions. In addition, we were able to videotape the factory floor and one training session. We also made some attempts to interact with workers outside the plant—for example, we attended a company softball game and we visited a community-based immigrants' association where several Korean workers went for tutoring. Our out-of-factory fieldwork was very limited, however, due in part to the complexity of studying the factory itself and also due to our limited entree to immigrants' communities.

Our fieldwork at EMCO (over one hundred visits between May 1993 and September 1994) resulted in over two hundred hours of audio tape of work in all departments, training, and interviews; six hours of video tape of training, manufacturing and a team meeting; a database of all employees' education and work experience; a collection of documents including process instructions, engineering changes, and assembly drawings, performance reviews and disciplinary notices, quality alerts and corrective action requests, supervisors' passdowns, workers' notes and drawings, meeting agendas, inter-office memos and much more.

Teamco

Three flags mark the entrance to the Teamco "campus": the US stars and stripes, the California state bear, and the Teamco emblem, which looks something like a star burst or an electrical storm. Even if you didn't know that the company was successful, a force in the industry to be reckoned with and a business institution quite conscious of its public image, you would likely reach such a conclusion by touring the Milpitas plant: Large flat building after building, gleaming white in the sun, flanked by parking lots filled to bursting, everything neat, shiny, and clean, and everywhere hundreds of Asian workers and other people of color, busy, intent, and purposeful.

We first learned about Teamco by reading trade journals—mostly articles describing its rapid success and its management strategies—and we continued to monitor these journals as our study progressed. The story of Teamco reads not unlike the entrepreneurial success stories of other Silicon Valley companies with similarly humble beginnings. In the unique regional culture of ~~the~~ Silicon Valley, the story goes, visionary men were able to parlay an ingenuous business sense and a willingness to work hard into an electronics empire, and that empire bred other visionaries who eventually formed their own companies. And so, Teamco was founded in the late 1970's by an executive with management experience gleaned from a major computer company. It began as a small repair house for certain types of printers but moved quickly into circuit board assembly. Its sales increased twentyfold in ten years, and in 1994 the company reached a sales figure of well over a billion dollars. Teamco is now touted as one of the "hottest" manufacturers in the Silicon Valley, the recipient of scores of customer awards and national and international recognition.

Accounts of Teamco's success in the 1980's pay homage to its adherence to Japanese-style management strategies, and indeed, the company's president is said to have made several trips to Japan to study their techniques firsthand. Kaizen (continuous improvement), the Five S's (Japanese words beginning with "s" for orderliness, cleanliness, discipline, etc.), poka-yoke (mistake-proofing the process)—you name the quality enhancement approach, and Teamco executives have been glad to try them. More recent accounts of the company highlight its investment in its multi-cultural workforce. First came Teamco Tech, an in-house university, which offered courses not only in basic electronics and statistical process control, but English-as-a-Second-Language and American Culture. The impetus for this venture was said to have been management's desire to improve communication—its workers speak some fifteen different languages and forty dialects—and formal training was seen as one way to accomplish this.

Three years ago began Teamco's current self-improvement initiative, the organization of the factory around "self-directed work teams" (SDWTs). The brainchild of a manager in charge of strategic development, this effort involved first, a series of seminars for mid- and upper managers, to introduce the necessity of a site-wide reorganization around teams and the reduction of management layers. The next step was to create a curriculum and training program for non-exempt or hourly workers, and to put three thousand workers through some thirty-eight hours of training. In conjunction with the training or after its completion, workers were divided into approximately two hundred SDWTs which corresponded to their work areas. The most recent phase of the project is the linkage of compensation to team performance—determined by whether individual teams have been able to meet their productivity and quality goals for the quarter. There was also a system to reward individual teams, who competed against each other at company-wide forums and were judged on their presentations and their problem solving. Our research allowed us to observe the training, to sit in on meetings and competitions of a range of teams, and to follow the progress of these teams from their beginning through three quarters of work.

Like the quality enhancement programs started earlier at Teamco, the impetus for self-directed work teams seemed to be a corporate will (similarly espoused by most of today's Fortune 500 companies) to continue to improve, to embrace change as inevitable, to try whatever might work in a never-ending, all-consuming quest to remain competitive in a cut-throat marketplace. Whatever could be done to better serve the company's customers—that is, to increase productivity and to decrease quality flaws—should be done. Although Teamco's past management strategies for increasing its marketshare and its profits had certainly paid off, and handsomely, current thinking at the company was that what worked in the past couldn't be trusted to work in the future, and that they would be foolish to rest on their laurels. And so began what various Teamco executives and trainers have referred to as a "culture change," the introduction of a whole new way of thinking, acting, and being for workers and managers both.

This change was billed by most as a major shift, despite the company's past history of embracing quality enhancement programs. For one thing, organization of the company around self-directed work teams required all of the different divisional units of Teamco to play the same music, to read from the same page, rather than to operate autonomously. In the past, we were told, each division of Teamco had acted virtually like its own little company, with little interference or help from upper management, so long as they turned the expected profit. That would come to an end, now, as workers in all divisions experienced the same SDWT curriculum and all were divided into teams, and as the company oversaw each team's performance by measuring their achievement of team goals, and compared that performance across divisions.

A second challenge to reorganization around teams was the company's diverse workforce, with its myriad languages and cultures. Teamco had long been known as an "Asian" company, though this term falsely implies a homogeneity that does not exist among people from many different Asian cultures. In recent years Teamco had also begun to hire non-Asian-American workers; it is said that the impetus for this change was becoming a public company and worries about lawsuits regarding discrimination. Many workers were then, and still are, recent immigrants, and since their English skills are still developing, speak to each other in Chinese or Vietnamese or Spanish on the shop floor, and tend to associate mostly with members of their own cultural groups. Such linguistic practices are workable, company executives reasoned, as long as divisions operate autonomously. But once a company culture calls for collaboration, for cross-divisional communication, indeed for teamwork, then there is a need for a common language, English, and a shared workplace culture that traverses ethnic boundaries.

Finally, we should note that the company's reliance on a largely temporary workforce also seemed certain to affect its effort to bring about a culture change. In fact, the company practice is to hire no employees directly; everyone is brought in as a temporary employee through a local temporary agency. At times as many as half of the factory's non-exempt or hourly employees were temporaries. Whether these employees were made permanent (and then received benefits like health insurance), and when they were made permanent depended on the vagaries of business, of customer demand. This hiring practice of course has ramifications for training—the official policy at Teamco is that workers must be made permanent before they can attend SDWT classes, though practice on this point varied—and one would think that it would have an impact as well on workers' commitment to their company's culture change.

As at EMCO, our public and official role in this factory was "researcher," a group come from a local university to study the company's attempt to reorganize itself around self-directed work teams. But unlike at EMCO, the manager who gave us entree was interested in our impressions of the training provided by the company about teams. As members of a School of Education, he believed we might have insights about the curriculum, and we all viewed the exchange of those insights for the chance to observe the reorganizational process as a fair deal. Thus, it came to pass that our research team attended the training program provided to induct workers into teams, and we next attended the meetings of a variety of teams. In the latter context, we were sometimes called upon to help out, in the role of teachers rather than co-workers. The assistance we provided team members often had to do with literacy issues—for example, we taught team members to read graphs, use computer programs, and apply mathematical formulae. And we provided some technical and research help to the company, mainly in video-taping and editing segments from team meetings for use in the curriculum. We also attended and video-taped "team competitions," sessions at which teams presented to managers, outlining the manufacturing problems they had identified and presenting data on the solutions they had implemented.

At Teamco our fieldwork (over two hundred visits between September 1994 and November 1995) yielded more than three hundred hours of audio tape of work in all departments and of training, interviews, and a variety of meetings (including SDWTs, the goal review board, site coordinators and management quality reviews); approximately one hundred hours of video tape of SDWT training, SDWT meetings in seven functional areas on two shifts, goal review board meetings, and SDWT competitions and presentations to management. Also, as in our fieldwork at EMCO, we collected a wide range of documents, from the training curriculum, process instructions, and time standards to workers' notes and drawings, quality and productivity data, meeting minutes and agendas, and management assessment of team goals.

Readers who are interested in the short version of this story should now turn to the final sections of the report where we present and discuss our major findings. Those interested in a detailed account of our research should read on. We offer in the following sections narratives of work events, team meetings, and training sessions or classes (the same narratives, by the way, will appear in our data base). And we present these narratives in some detail, introducing the workers who figure prominently in them, providing excerpts from their conversations, and describing and summarizing their work or training activities. We have chosen these narratives strategically, to illustrate the important themes we saw in our data, themes that we return to in our findings. We begin first with narratives from EMCO.

EMCO: A Re-Work Event

It's important, if we are to understand how literacy does and doesn't function on the shop floors of EMCO and Teamco, to know something about the work of circuit board assembly, for this work structures the reading and writing that gets done in these factories and gives literacy its purpose. Before turning to a detailed examination of a particular aspect of circuit board assembly, we offer a quick glimpse, a broad sweep of the work that people do on such a manufacturing floor. We will catch this glimpse by following a "bare board" and a kit of components (integrated circuits, diodes, resistors, capacitors, brackets, nuts and screws, and so on) across the manufacturing floor on their way to becoming completed printed circuit boards. This is something of a generic description, one which fits generally the circuit board assembly process in both EMCO and Teamco. Any one of these steps might be skipped, depending on the design of the particular board and on the current technology in place in the particular plant.

When bulk components arrive in the Storage or Shipping department, a "Kitting" crew consults various documents—manufacturing schedules, Manufacturing Process Instructions (MPIs), Bills of Materials (BOMs), Approved Vendor Lists (AVLs)—to determine how many of which components are to be placed on which boards in which areas. They then make up kits of those components, kits which will be picked up as needed later in the shift by materials handlers from the various departments. Out on the floor, the bare boards begin in an area referred to as "pick-and-place" or SMT (surface-mount technology) which consists of lines of robots. A worker programs the machines to either spread solder paste or squirt daubs of epoxy on the board and then place the right components in the right spots on the board. The boards, with components in place, continue along an automated line through an "oven" or reflow machine which heats up and solidifies the solder. Although it is possible for a single person to load the machine, monitor the process, and catch the boards at the end of the line, it is more common for two people to share these responsibilities, with the person who catches the boards acting as an inspector to see that all parts were placed on the board properly. Roving inspectors also conduct spot checks here and throughout the plant.

A worker (a "materials handler" on some shifts, pick-and-place "lead" on others) places the boards on trays or in sectioned bins called "totes," sets the trays or totes on carts, and wheels the carts to a washing machine. (At EMCO, a movement log is filled out in triplicate and filed to document this and all transfers of materials in the plant; at Teamco, a one-page "traveler" is filled out to accompany the cart but also boards are scanned at certain points to track them along the manufacturing process.) Another crew of one or two runs the boards through the wash, puts them back in bins, then on carts and wheels them either to "Auto-Insertion" (AI) or to "Stuffing" (also known as "Hand-Load"). Though board designs rely increasingly on surface-mount technology, all boards still contain at least some "pin-through-hole" components, components which have small wire "legs" or "leads" which stick through small holes in the board and are wave-soldered or hand-soldered on the back side of the board. Some of these through-hole components are placed by machine in the (AI) area after going to SMT, others by hand in the Stuffing (Hand-Load) and Mechanical Assembly areas. Stuffing is a line of perhaps a half dozen workers who hand place more components on the board, components which because of size or shape or other characteristics could not be placed during the earlier stages of the process. The components added in AI, Hand-Load or Mechanical Assembly require soldering and so are moved, according to the customer's specifications, either to the Wave Solder area (staffed by one to three operators, the wave solder machine makes it possible to solder the leads of through-hole components *en masse*, an important time-saver when a single connector might have a hundred leads or when a board might have a few hundred small through-hole components, each component with at least two leads) or to the area known variously as "Second Ops" (second operations) or "Touch-Up." Second Ops is the most labor intensive part of the plant. It is here that workers (usually women) perform hand soldering known as touch-up (adding final components) and re-work (removing and/or replacing components). Second Ops also includes some hardware assembly, where workers screw brackets to boards, add bar code labels, and snap in components that don't require soldering or that cannot be subjected to the wave solder process. The assembled boards are then "shipped" to another department for in-circuit and functional testing and quality inspection. Depending on the results, the boards are then either sent back for re-work, or packed and shipped out. Surrounding and interacting with the manufacturing process described here is the work of designers, engineers, and managers of various kinds—the people who prepare for and oversee the manufacturing process and who interact with customers, vendors and employees at other plants owned by the corporation.

Now, let us take a fairly detailed look at circuit board assembly in action along with the people who do this work. In particular, we will examine a work event in Second Operations, the most labor intensive of all a circuit board assembly plant's operations. This work event is a very common one in the industry and is called "re-work."[2] Although this particular re-work event took place at EMCO, it represents a type of work task common to both factories. That is, a customer like Apple or Intel or Hewlett-Packard decides that the design of a board currently being assembled by its contract manufacturer needs to be altered. Then, all of the boards that have been assembled or even shipped are returned to the factory floor, and a certain section of that board will be re-worked or altered according to the specifications of the customer. As will shortly be apparent, work activities are much more complicated than the seamless description of the process we provided earlier would lead one to believe.

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[2] "Re-work" in this instance is customer-initiated, the result of a customer's design change, and so the cost of the extra work is absorbed by the customer. "Re-work" also refers to the work necessitated by glitches in the company's process, whether machine malfunction or operator error. This sort of re-work—correcting solder problems or replacing misaligned, reversed, or wrong parts, for instance—is time-consuming and costly for the company. Reducing such re-work is the constant target of a company's quality push.

Our work event—which took place in the space of about fifteen minutes— begins with an engineer, Leonard,[3] a 62 year old who recently lost his job at another factory, and Maggie, the second shift supervisor and a woman with 28 years of experience in the industry, as they discuss the directed engineering change. Let us introduce Leonard and Maggie and a few of the others on second shift in some detail—enough to give a sense of their backgrounds, talents, experiences, and challenges—information helpful in understanding their behaviors and attitudes in the subsequent re-work event.

- Leonard, 62 years old, European American, grew up in Pennsylvania and went to a vocational technical high school, where he trained to be an electrician. During the Korean War he joined the air force and graduated with honors from, then taught in, their electronics school. Following the war he attended Cal Poly on the GI bill and earned a BS in electrical engineering. He had to, as he put it, "take bonehead everything as an undergrad, bonehead English, bonehead chemistry, bonehead mathematics." After graduating from Cal Poly in 1960 with a 3.8 grade point average, Leonard went to work for RCA, who paid him to attend grad school at UCLA for a Master's degree. He made it to the thesis stage but claims he was "just too damn lazy" to write a thesis. In the late 80's, after nearly 30 years in the industry in capacities ranging from design engineer to marketing, Leonard was laid off. "I'm 60 years old, got gray hair. When I first started putting out resumes, you know, I listed everything. Well, shit, I never got a call. Nobody ever called me." A friend advised him to list only his last eight years' experience and not to include dates that would give away his age. He took the advice, and the calls started coming. He notes ,"That's the first time in my life I'd ever been unemployed. I mean, I know a lot of guys that just gave up, finally just gave up looking for work. I mean, hell, you know, with college degrees. You know, the one thing that's saving my buns is that, number one, I took this job at considerably less pay than what I was making before. And I kept my hand close to the hardware. A lot of guys my age, they haven't been near the hardware for quite a while." Leonard, who's still not comfortable with paper work, has been at EMCO for a couple of years now.

- Maggie is in her early 50's and has 28 years in the electronics industry. Immediately out of high school she left Renton, Washington, and headed for California, afraid that if she stayed in Renton she'd end up like her mother, working "a dead-end job" as a riveter at Boeing. Maggie found work in a bank, but it didn't pay enough to live on. A friend's mother was a manufacturing supervisor at a semiconductor plant and got Maggie a job there working under a microscope, doing die attaching and bonding. A year later, after going through a divorce and having just lost her job, Maggie and a friend met a couple guys in a bar who suggested, "Why don't you come down to this company tomorrow and put your application in?" She did, and she was hired, with no experience. In fact, she says, "They had to train me to hold a soldering iron." The move, which she calls "a fluke," took her out of semiconductors and into printed circuit boards. She notes, "I started from ground zero, working in electronics. And it was just sitting at the bar, dancing and talking with these two guys, and that got it all started." She's done practically everything in the industry: the tedious handwork called "through-hole" manufacturing, hardware assembly, touch-up, re-work, wiring, building power supplies; she even tried to set up her own circuit board manufacturing business. After that venture failed Maggie tried to get into the hard drive business, but was told she needed a BS despite her years of experience. She finally returned to printed circuit boards, settling for a job doing touch-up, which quickly led to a lead position, and finally supervisor, the position she now holds on swing shift at EMCO. We asked her what it takes for a worker at EMCO to move up to supervisor. She looked through the list of names of supervisors and commented that with a couple of exceptions, most supervisors, like her, are "some kind of white."

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[3] All names are fictitious.

- Eduardo is Filipino and has a BS in mechanical engineering from the Philippines. He worked for ten years in his native country in supervisory and management roles for an oil refinery, an explosives manufacturer, and a glove manufacturer. When he and his wife came to the United States in 1988, he discovered that "Whatever education we got in our countries...is not recognized here in America." After sending out nearly fifty applications in his first month in the States, and being told he either had the "wrong" education or was over-qualified, he found a job in the electronics industry doing mechanical assembly. "The first time I got my job here," he says, "there is a shock on me. The kind of job I am doing before, I'm handling people, I let those guys do the work for me for the company. And now ... I'm doing that simple kind of stuff. So it's really a, shall I say, disappointing one?" Eduardo now is lead assembler in the hardware and Wave Solder department of EMCO, where he runs a machine that applies solder paste to attach components to circuit boards. He has worked there for a little over a year, earning from eight to ten dollars an hour. He hopes to go back to school and study "whatever will be the best for me." But those plans will have to wait because, as he says, "right now I have a family, I have little kids to take care of. My youngest son is only four months and a half. So maybe when my youngest will be grow old, maybe five years old or six years old, maybe that's the time that I'll have some extra time. When I send him to school, maybe I go to school also." In the meantime, Eduardo continues to work swing shift while his wife works days at another electronics firm. And he yearns for the chance to make his management views known in the factory; in fact, he longs to be a manager as he was in the Philippines.

- Hee-Fon worked as a sales clerk in a department store in Seoul, South Korean until just before coming to the US in 1979 at age 30. Just married, she and her husband had come to live near her sister and mother, who had immigrated to San Jose a couple years before. She began working in electronics in 1982, took time off in 1984, then shortly after the birth of her second child in 1986 returned to work in electronics for the Korean-owned company EMCO eventually purchased. She has worked in Touch-Up, Hand-Load and Mechanical Assembly, and was made lead of the Touch-Up area two years ago. She enrolled in ESL classes, five days a week, three hours a day during the last months of our fieldwork at EMCO, and is still enrolled. She says the class is hard, maybe too hard, but with Eduardo taking over responsibilities in other areas of the plant, she finds greater and greater need for improving her English communication skills, especially her reading. Big headache, she says. Usually she delivers boards to people, does whatever extra touch-up and rework needs to be done, fills in movement logs, but leaves the MPIs to Eduardo; he reads them and conveys the information orally to Hee-Fon and the rest of the workers. She is able to read English, but only "little bit, not much. Too hard." Outside of work she doesn't have much opportunity, nor much time, to practice her English or to do her ESL homework. Her husband insists that they speak English at home, which she says is fine with her because she doesn't want her two children to forget how to speak Korean. What she says should be study time is taken up with getting her son to high school and daughter to elementary school in the morning, getting herself to school, then rushing home, fixing a dinner that will be ready for her kids and husband to eat, picking up her kids at school and bringing them home, then rushing off to work by 3:00 p.m. When she works overtime, which has been often lately, she gets home after midnight, about the time her husband is getting up to go to work. He used to work in electronics, but just recently he started up his own bait shop in Vallejo. Now he gets up at 3:30 a.m. to leave the house by 4:00, returning home about 7:30 p.m. On Saturdays, she takes her kids to Korean school (they know how to speak the language, she notes, but they're learning how to write it) and spends a very little time with her husband, since he works on Saturday and Sunday as well. She says she doesn't feel like spending what time she has at home looking up words in an English-Korean dictionary. Her practice with English, then, is in class and at work, but at work she has little interaction with anyone who speaks English as a first language. Her supervisor and co-workers note they had never seen Hee-Fon so nervous as when she was given responsibility for reading the MPIs and communicating the information to other workers. One of the workers on her line said that for the first couple weeks of this division of duties Hee-Fon had several questions but would wait until Maggie, her supervisor, had gone to dinner and then would ask Eduardo to come over and help her. Hee-Fon recently passed her citizenship test and is now considering changing her name to Valerie. She says she's tired of people calling her Hee-Haw.

- Li is ethnic Chinese from Vietnam, where he attended high school but didn't graduate. He grew up bilingual, Vietnamese and Cantonese, and later learned Mandarin in school. In 1979 he left Vietnam for Hong Kong. There he found a variety of work, including mechanical assembly in an electronics manufacturing plant. He has worked for EMCO only one year, although he has eleven years' experience in electronics prior to EMCO. Along with his work in Hong Kong, that experience came from two US companies, including the one where Maggie had been supervisor before coming to EMCO. In fact, Maggie has called Li "one of my best," and has said she made a special effort to convince him to transfer to EMCO when she did. Interestingly, the first US company Li worked for was Teamco. He notes that Teamco, with its training program, was "good for Vietnamese refugees" because they (Teamco) would hire anyone with no experience and train them, thus giving them a way into the industry. We last saw Li some six months after we had completed our research at EMCO. We were just passing through the guard station at Teamco, on our way to observe a team meeting, when we saw Li head out the gate toward the parking lot. On his white smock was the pink badge worn by Teamco's temporary employees. We said hello, expressed our pleasant surprise at seeing him there, and wondered when he had EMCO for Teamco. He smiled shyly (or perhaps slyly) and said he still worked for EMCO. In fact, he couldn't stay and talk because he had only fifteen minutes to drive the few miles down the freeway to EMCO if he was to clock in on time for the swing shift.

- Lee was a second-year university student—a top student in his class in math, he says—in his native Cambodia when the Khmer Rouge captured Phnom Penh in 1975. He and his brother and sister were among the many forced out of the city and into the country to work on the farms. Lee now refers to being forced into the country as an "escape" since, as he notes, most of the people connected with the university and government were killed. His sister, who had been a science student in the university and was about to graduate, was too weak to bear up under the farm work, fell ill and died shortly after they were sent out of the city. During the fighting between the Vietnamese and Khmer Rouge in 1979, Lee escaped to Thailand where he spent a year in the refugee camp. It was there that he first learned to speak and read a bit of English from a man in the camp who knew English would teach it for a bribe. In 1980, through the sponsorship of a Taiwanese man living in San Juan, Lee came to the US. He took an ESL class for a couple months when he first arrived, but he couldn't afford any more than that as he had to find a job. Fluent in Cambodian and Mandarin, he notes that if he had the time, he would like to go back to school to take more English classes. He's been in electronics for ten years, only one at EMCO. He has worked in a variety of areas, though mostly Touch-Up and Mechanical Assembly, and was recently appointed re-work specialist in the Test department.

- Thuy came to the US shortly after finishing high school in her native Vietnam in 1986. After taking some ESL classes and a short electronics training course, she began working in electronics with EMCO in 1988. Since then, however, she has worked for three other companies, always in Touch-Up. She had been back with EMCO only six months and was still a temporary worker at the time of the following re-work event. A couple months after this event, Thuy lost her job (along with nearly 100 other workers, or about a quarter of the workforce) when EMCO hit a serious downturn that lasted about six months. Maggie later said that Thuy was one of the first laid-off workers she asked the company to call when they began re-hiring, but Thuy said no thanks when she heard they would be hired back at a lower rate than they were earning when laid off. She had already found work for a slightly better rate at another circuit board manufacturing company.

Now to the re-work event. In reading the following summaries and excerpts from transcripts, it would be helpful to watch for indications of several things: (1) the way that work is structured, such as who is in charge, who makes decisions, who carries them out and how; (2) the role and nature of literacy in this process, especially how and which workers use a combination of written instructions, diagrams, and sample boards to do their "re-work"; (3) the collaborative nature of this process and how it is carried out across different cultures, languages, and factory positions.

The work event starts on the shop floor with Maggie looking through the documentation on what's called an engineering change—a set of written prose instructions and a detailed diagram of the board called an assembly drawing (see Figures 1 and 2). These documents had been prepared in part by Leonard. Then she begins to look for a special fine-tipped cutting bit for a high speed rotary tool called a "Dremel Tool." All of this takes place as she banters with Leonard about not answering his page over the loudspeaker. Then Leonard introduces the matter at hand, the engineering change that will require re-work:[4]

Leonard	I'm havin' all the- the measurement boards [acc] sent back down/
Maggie	Well no sh:it
Leonard:	Okay? So,.. here we go again [sighs]
Maggie:	Yep, here we go again
Leonard:	[singing] I hear the TRUM-pets blo:w agai:n
Maggie:	Okay, and you're s'posed to have a, uh, sample board? [still looking at the "Manufacturing Process Instructions," with the new "Engineering Change Notice" (ECN) attached that necessitated the boards being sent down from Test]

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[4] In this section we provide what is called a "close transcription" of talk. That is, we have incorporated information on the tempo, stress, pauses, overlaps, etc. For example, "acc" in brackets indicates that speech is accelerated, and words or syllables in all caps indicates stress. The symbol = signals that speakers are overlapping their conversational turns, and a series of periods indicates pauses. The reason for this close transcription is to give a better sense of what talk is actually like and to aid in interpretations of speakers' intentions. For the complete transcription key, see Appendix B.

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Leonard: Yep, [acc] got a sample board. You can only look at it. He wants it back

Maggie: [acc] Well, pttttt [makes a 'raspberry' sound]. I have to make a sample before he gets it back then, don't I/

Leonard: Well, no, it's very well detailed, and a excellent drawing [referring to assembly]

Maggie: Yeah, r:ight

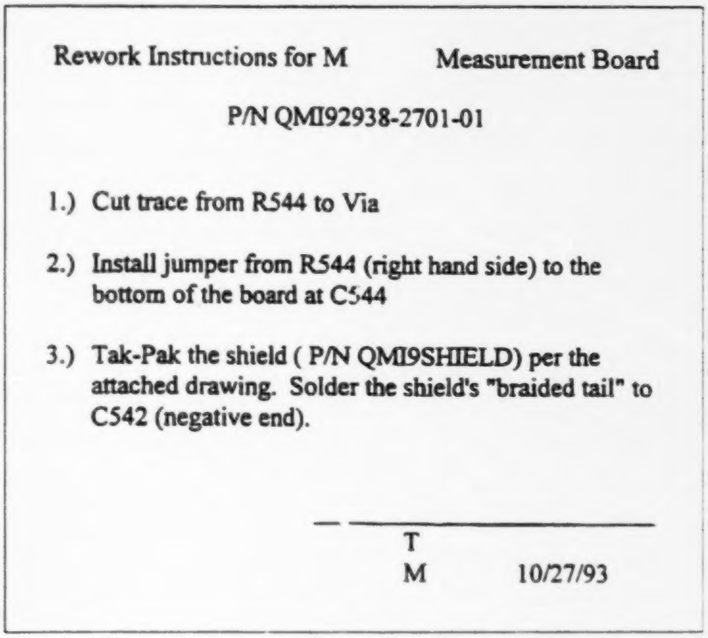
Leonard: [laugh]

Maggie: [laugh] .. [pp] Hmm, I shoved that in, now I can't get it out...cut trace.. open u:p, c'mon chuck.. got a small chuck, and a big tch- and a big bi:t. =[f] And I had to stea-= [f][high pitched] Huh?

Leonard: =What are you doing?=

In the above excerpt, it's important to note that while Leonard informs Maggie that she will soon receive a batch of boards to work on, she pours over a written document, a set of directions on how to perform the re-work. Part of the tension that is apparent in their interaction (cf. Maggie's sarcasm regarding the "excellent drawing" and Leonard's nervous humor and flights into song) has to do at least somewhat with the additional work that is suddenly being required. But the two also differ on the importance they assign to using blueprints vs. a sample board as a guide for the re-work—that is, an actual board that has already been altered rather than a drawing of one. Maggie claims, as she scours the blueprint, that her workers will need to make their own copy of the sample board before it is returned to the customer, but Leonard, an engineer who has taken part in drawing the blueprints, wonders outloud (and again it seems with humor) why the drawings aren't sufficient. These kinds of negotiations—and we will shortly see another example, this one regarding the Dremel Tool—highlight the different expertise of workers at different levels and from different backgrounds, and they also often reveal the interesting tensions that center around preferences for, understandings of, and access to different forms of representation.

Figure 1: Customer's Re-Work Instructions



Rework Instructions for M Measurement Board

P/N QMI92938-2701-01

1.) Cut trace from R544 to Via

2.) Install jumper from R544 (right hand side) to the bottom of the board at C544

3.) Tak-Pak the shield (P/N QMI9SHIELD) per the attached drawing. Solder the shield's "braided tail" to C542 (negative end).

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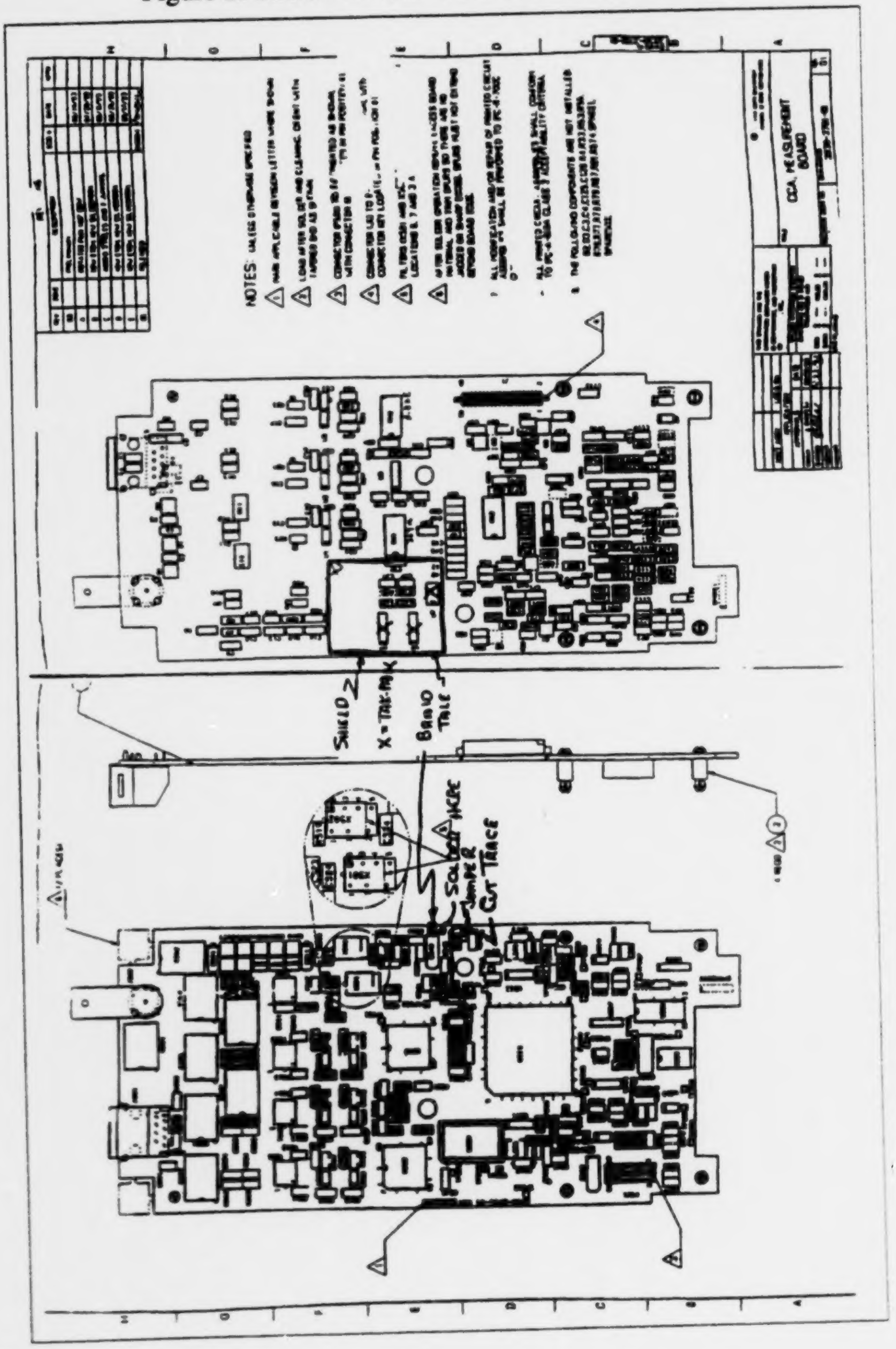
The conversation continues as Leonard and Maggie argue over the relative merits of the Dremel Tool compared to a small Exacto knife for cutting the new tiny trace in the circuit board. They walk together to the department called "second operations," where workers do handwork of various kinds using microscopes and tiny implements. The sound of the nearby wave solder almost drowns out their voices. Maggie guesstimates the "time standard" for the re-work—so many seconds allowed to perform this or that little task—as she refers to the written instructions again. (This time standard is critical, we should note, for it is connected to how much the company will be paid for the work. We have noticed that many conversations between individuals and during team meetings are devoted to arriving at these numbers, which are based on experience and good guesses.)

Next Maggie and Leonard address Eduardo (the Filipino lead with an interest in management ideas, like quality circles) and Hee-Fon (a Korean lead who's been in the factory for ten years). They warn the two leads that there's about to be a stampede of measurement boards coming down from Test and that they'll have to incorporate the new engineering change. These leads are employees who have leadership roles for individual "lines" of workers, such as the workers in second ops or in Wave Solder. Frequently, for example, the leads translate from English to Korean for the employees on their line, and

Figure 2: Customer's Re-Work Assembly Drawing


SHIELD
X = TAK-PAK
BRAID TAIL
SOLDER HERE
JUMPER
CUT TRACE
NOTES: UNLESS OTHERWISE SPECIFIED
CCA, MEASUREMENT BOARD

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they are the liaison between line-workers and engineers and supervisors like Maggie and Leonard. At EMCO leads are the only assemblers who are actively encouraged to read Manufacturing Process Instructions, the main printed document that accompanies each type of board; they are expected then to explain the instructions to the workers on their line. We should note that at EMCO, unlike at some of the other contract manufacturers in the Valley, leads are not compensated for their extra responsibilities—and that this was understandably a sore point for many.

Rather than showing Hee-Fon the diagram, Leonard uses the sample board to illustrate the engineering change. He demonstrates which trace[5] should be cut in the board, as Hee-Fon examines it under a microscope. The conversation becomes increasingly deictic, as everyone gathers around to watch Hee-Fon cut the tiny trace and attach a jumper wire. Eduardo questions whether there isn't a need to "tak-pak" the wire, and Leonard first says no, but then agrees with Eduardo and Maggie that some glue is needed at the bend of the wire. Leonard starts to leave, reminding them he needs to return his sample board to "Tonto," a reference to a customer who'd been following Leonard around for the last month. But he stops, unfolds the assembly drawing, and gives it to Hee-Fon, and then he and Maggie argue some more about the Dremel Tool vs. the Exacto knife. In this exchange it is important to note that Leonard accepted the suggestion made by the line worker to "tak-pak" the wire and also that Eduardo, the line worker, felt both comfortable and knowledgeable enough to make the suggestion. It is also interesting that the drawing (with its writing) is offered only after the change has been manually demonstrated.

Leonard and Maggie wander off, still arguing the relative merits of Dremel Tools and Exacto knives. Hee-Fon and Eduardo stay at the work station, and Hee-Fon begins to make her own sample board, following the sample board Leonard left. She looks at neither the drawing nor the written instructions, only the sample board. Eduardo looks over Hee-Fon's shoulder as she works. They don't say much, and when they do they speak softly, and they give each other suggestions about how to solve the particular re-work problems for this board, suggestions they will pass on to the members of their line.

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[5] A "trace" is a copper lead (or wire) embedded in the circuit board. To "cut a trace" is to cut through or sever that lead. In this case, the trace is cut in order to disconnect two components, and then a "jumper" or extra wire is soldered on top of the board in order to reconfigure the connections. The concern over which tool to use is related to the fact that current circuit board technology requires several traces to be layered throughout a board. Cutting a trace requires a combination of the right tool in the right hands, because a cut too wide or too deep may damage a trace that should be left untouched.

Then, having made their own sample board, Eduardo and Hee-Fon turn their attention to organizing the work flow for this new process:

Thuy: [yelling] Eddie! Eddie!

Eduardo: Li will cut the trace? You will put- you will put the a:h- you will put u:h tak-=pak=

Lee: =Tak-pak=

Eduardo: And then:==

Lee: ==Put wire==

Eduardo: =Put wire=

Lee: =Tak-pak= Tak-pak here you say? Okay/

Thuy: ( ) Li

Eduardo: Yeah

Lee: [acc] Tak-pak here, see, only one tak-pak here, huh?

Hee-Fon: =No ( )=

Eduardo: =No, only one= only one at the bend/

Hee-Fon: Only one==

Lee: ==I solder this one to here. I can:- solder this one? Tak-pak here? Tak-pak on that/

The talk continues for fourteen more turns as they each initiate and then repeat the instructions, sometimes several times. It's interesting to note the collaborative and overlapping nature of the talk that occurs in this excerpt, as the workers translate the changes on a board they are all familiar with (having manufactured it earlier, before re-work was ordered) into a process they will all participate in. They simultaneously figure out the steps of the process and assign responsibility for accomplishing each.

In the following excerpt, as they set up the work flow process, Eduardo and Hee-Fon have to decide where to seat their three workers. First they move line workers—Li, who is of Chinese heritage from Vietnam; Lee, Cambodian; and Thuy, Vietnamese—and the necessary carts, totes, and supplies, from one line[6] to another, and provide instructions on how to carry out the process. Then they realize that another arrangement makes more sense. They had initially set up Li and Lee side-by-side on line three but quickly saw this was unsatisfactory, as there wasn't enough room for the third person. Since it would be inconvenient (and inefficient) to pass the work along to the third person if that person were anywhere other than next to the other two, Eduardo and Hee-Fon are about to ask one of the workers not involved in this process to move to make a third space, when they note that there are three spaces in a row over on line one, right next to Thuy, the woman who'll be soldering the jumper wire. Thus, they move the whole operation, workers, carts, totes, supplies, over to line one. After a few minutes of noisy, frenzied pointing and planning, Eduardo appeals for calm amid the flurry of laughter and movement, and Maggie comes to see what's the matter:

Eduardo: (You) don't know what's going on. So maybe, you know, calm down a little bit, so we can set up, you know, whatever will be the best...

Thuy: [calling] Eddie, over here

Eduardo: Makes sense on this side==

Hee-Fon: ==Yeah?

Maggie: What? [laughs] Wha: hoppen? They didn't wanna sit over there?

Hee-Fon: No, she make-ee wiah (making wire). Wiring.

Maggie: [surveying the scene] Ohhh =[laughs]=

---

[6] It might be helpful to know that at EMCO each work "line" is one side of a long work bench, five workstations to a side. A workstation consists of a tall draftsman's chair, a grounding wrist strap, a microscope, a magnifying lamp, a set of solder irons, a toolbox and assorted supplies. In the middle of and running the length of the workbench is a tall, open wire rack or shelf. On the shelves are, if anything, assembly drawings, lists of work codes, copies of the company's monthly newsletter, and other written material. The rack's main function seems to be to demarcate the work lines. As is the case on most evenings, the workers in second ops this evening are spread out along all four work lines.

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Hee-Fon: =( )=

Eduardo: =Makes= sense with three stations available. That side only two. So:.. =make one=

Maggie: =[f] Teamwork!=

Eduardo: One flow==

Maggie: ==Uh-huh

Eduardo: =Flow line=

Maggie: =and a flow= too. All right, I love it.

We should point out that Maggie, in this instance, seemed pleased by the fact that the assemblers had found their own solution in creating one rather than two lines and in dividing the work up into steps with each person performing a discrete step. She declared this an example of "teamwork." Her response in this instance was particularly ironic in light of a meeting that Maggie had initiated a week earlier.

In response to a problem she believed was caused by the work organization described above, in which a task was broken down and each worker was responsible for a discrete part of the task, Maggie had suggested that each person be responsible for doing the entire task on a single board. The problem was that several boards were missing pieces, and she reasoned that this new work organization—or "teamwork" as she called it—would insure that no board was passed in an incomplete state to the next station. The workers disagreed. They declared that their current practice which *they* called "teamwork" was effective and that the problem stemmed from part shortages and instructions to run the boards even when certain parts were missing.

The irony in this vignette is that when Maggie declares that their newly formed line is "teamwork," she is commending a practice she had tried to change a week earlier. Such conflicts and conflicting opinions reveal who in the workplace is considered skilled and by whom, and who is allowed to exercise skill. It is notable that in this instance a change in work organization was initiated by the assemblers themselves and that it occurred in a climate that allowed them to determine how to organize the work themselves. It is also interesting that these negotiations and decisions occurred without workers' consulting the written instructions which were on hand.

Finally the line is established, Li cuts the trace (with the Dremel tool!) and passes the board to Lee. Lee lines up the shield on the back of the board, then holds the shield in place as he turns the board over and lines up the ground strap. He solders the ground strap, then turns the board back over, spreads tak-pak on the top of the three integrated circuits, presses the shield in place, spreads tak-pak on a spot on the board, presses the final corner of the shield down and holds it for a second. He places the board in a tote to his left, between him and Thuy. Thuy sits at her workstation, with the sample board, a set of drawings, and written instructions in front of her, and cuts the insulated wire to length and solders it in place.

Commentary on the Re-Work Event at EMCO

The re-work event begins to capture some of the significant features of work at EMCO and the role of literacy and language in that work. And it raises many questions, questions we will need to keep in our minds as we look at other work events and at meetings and classes.

First, we think the re-work event suggests much about the collaborative and problem-solving aspect of circuit board assembly. We see, in the transcript excerpts, lots of people putting their heads together, so to speak, defining a manufacturing problem and solving it expeditiously and accurately. Interestingly, this collaborative problem solving occurs, and occurs successfully in this instance, across daunting boundaries of ethnicity, language, gender, age, and the company hierarchy. Here an older European American male engineer and a middle-aged European American female supervisor interact with each other and with a Filipino who's a lead in the re-work department; a female Korean, also a lead; a Cambodian man; a Vietnamese man, and a Vietnamese woman—all line workers of various ages and levels of experience. Together they carry out the needed activities of interpreting instructions, comparing and reproducing representations, cutting traces, soldering, and placing components. Further, in this case front-line workers took the opportunity to organize a work activity, to translate an engineering change from a combination of verbal, visual, and physical (manual) instructions to a sequential process, and then to carry out the work. Thus, the re-work event illustrates that there are moments of problem solving on this shop floor which take advantage of the knowledge each worker holds.

Of course, there is much talk in the "high performance" movement about the necessity of problem solving and the value of teamwork on the part of front-line workers. One needs only to pick up a business magazine to learn of the increasing interest on the part of many companies in involving workers more centrally and formally in decision-making and problem-solving activities through self-directed work teams, the aim being to draw upon every resource possible to become more competitive. At EMCO, by contrast, the manager of the factory saw no reason to involve front-line workers in the team meetings that he had instituted for supervisors, engineers, and managers. However, problem solving and teamwork did occur informally as a natural part of accomplishing work activities, as we illustrated in the work event.

The interesting question about this factory, where traditional power relationships and traditional ways of organizing and thinking about work are very much in place, is does it matter? Of what consequence is it if work is handed down from engineer to supervisor to lead to line worker, and if there are no formal occasions for line workers to make suggestions about the process or organization of their labor? Conversely, when we move to our "high performance" workplace, where self-directed work teams are the norm and worker participation in problem solving is mandated, institutionalized and measured, we will want to ask again, does it matter? Does the process of work change or improve as a result? And of particular interest to us is the role of literacy in all of this.

Let us retrace a little of the literate activity which surrounded the above work event. We will recall that the engineer Leonard brought a set of MPIs (manufacturing process instructions, the compilation of directions that accompanies each board) together with a sample board to the floor in order to put the re-work process in motion. (In this case, the instructions referred to as an "Engineering Change Notice" (ECN), included in the MPI, was written by the customer, but in many cases they are written by EMCO engineers. In both cases, engineers discuss and interpret written instructions and blueprints verbally, sometimes with the customer and almost always with each other.) Further, instead of simply sending the boards to the floor with a written notice, Leonard accompanied the boards and the notice, demonstrating the board as he handed over the written instructions. The directions were then relayed verbally to the line workers who actually performed the work and translated them in the manner described above to their co-workers. While the instructions for this event were direct and concise (for example, "Cut trace from R544 [which refers to a location on the board] to Via"; see Figure 1), they generated a flurry of talk and activity. An added response to this written artifact was a repositioning of workers as they interpreted the instructions according to their capabilities and knowledge of the manufacturing process.

Thus, literacy had a number of forms and purposes in this transaction. When texts were used to provide information for the manufacturing process, they were used jointly with other forms of representation—with diagrams or schematics and with actual sample boards. So, an assembler will have in front of her a set of all three "documents," and she will refer to each as needed or according to her preference or custom. This is another example of the phenomena that Witte (1992) has pointed out, that in the world of work different forms of representation are much more available and relied upon than in school, where print is privileged.

It's also important to note that every written transaction was accompanied by a verbal explanation, and that verbal instructions were often paramount. The engineer and the supervisor talked about the required engineering change as the supervisor studied the documents, and they both relayed the written task to leads and lineworkers verbally. Workers compared and negotiated their different understandings of the verbal instructions through conversations (and, we should add, they managed to do this across cultures and across languages). In fact, in this traditionally organized factory, only leads were required to read manufacturing process instructions. These leads then were expected to convey the written instructions to their lines orally. Line workers were not expected to read printed instructions, and some managers even presumed that they were unable to do so because of language barriers.

Thus, the re-work event points to some important tensions surrounding literacy practices at EMCO. Considerable writing and reading were required at the factory, partly because of the nature of contract manufacturing. As the re-work event illustrated, customers often required changes to be made in boards that are being assembled. There is a need on these occasions to keep exact records of each change, deviation, and modification for every type of board, and to keep precise records of serial numbers, production dates, etc. for each individual board. Another factor which upped the literacy ante is that EMCO was certified by ISO 9000, an international standards organization which required that all procedures—literally thousands and thousands—be written down, updated, and distributed, and of course, read and followed.

But despite the fact that literacy requirements were considerable, even at this traditionally organized factory, access to and use of print literacy at EMCO was unequally distributed. Only engineers actually get to write manufacturing process instructions, and as we have illustrated, work was organized such that not all workers were expected to read them. It will be interesting to consider, as we move to other work events, whether the constraints placed on the literate activities of front-line workers actually had an impact on the work process. Were there occasions, for example, when releasing front-line workers from the responsibility of reading, when keeping from them the responsibility of writing, had negative consequences for production? Or did this not matter at all? And when we move to Teamco, our high performance workplace, will we see big changes, as we might expect, in the literate rights and responsibilities of front-line workers?

One final point from the re-work event. The transcripts make it obvious that this is a multi-cultural factory and that everyone's English isn't perfect. Indeed, one reason the factory was organized so that front-line workers didn't have to read was that they were perceived as non-native speakers, as having little English and therefore as not knowing how to read and as being uninterested in communicating outside their own ethnic groups. Yet, as we have pointed out, work got done efficiently and well during the re-work event, across languages and cultures. But we will want to be alert, as we move to other instances of work and training, and to our other factory, to the influence of culture and language on the working lives of circuit board assemblers. At EMCO, for instance, are Korean workers really so unwilling to learn English as some managers have concluded? What is the impact of linguistic identity on work identity and on chances to move up the almost non-existent job ladder? At Teamco, is there a greater need to speak English in order to communicate within teams, and what are the consequences, if any, of not doing so?

EMCO: Another Work Event

Literacy and Labeling

The following work event begins to answer one of the questions raised in the last event, that is, whether it matters that work is organized at EMCO such that front-line workers aren't supposed to take responsibility for reading documents such as manufacturing process instructions. The event also offers a different perspective on "basic skills" and the "skills poor" worker. The popular literature on workers' abilities and the demands of work (cf. Hull, 1993, for a review) often provides accounts of the "skills poor" worker: the carpenter who can't read a ruler and thereby makes mistakes in calculations; the machine operator who can't decipher warnings posted about the factory and therefore gets involved in serious accidents; the recent immigrant who is still learning English and thus miscommunicates in the pass-downs he must write for the next shift. The moral of these stories is usually that employers need to beware that their workers have skills deficits and to assume responsibility for the literacy, language, and other instruction that people didn't receive in school. Workers are likewise advised to retool, retrain, and remediate their deficiencies lest they lose their current jobs and not be able, in our current cold economic climate, to acquire new or comparable ones. (See The *Bottom Line*, 1988; Carnevale, Gainer, & Meltzer, 1988; Lund & McGuire, 1990; *America's Choice*, 1990; SCANS, 1992.)

This following event is also about a literacy problem in a workplace, this one a documented instance of EMCO workers who apparently failed to read or follow instructions and thereby narrowly avoided a production mistake that would have had serious repercussions for an important customer. However, the moral of this story won't be the standard warnings about a skills poor workforce and the necessity of basic skills instruction for an ever increasing number of people—though it is of course the case that some workers want and need to improve their language and literacy capabilities; this isn't at issue. Rather, we will suggest that to be truly literate, sufficiently skilled, and knowledgeable, employees also need access to a wider range of information about companies and their work than we have typically assumed, and they need as well the opportunity to exercise their literate capabilities. That is, work must be organized to allow, even to require workers to take responsibility for reading and writing on the job. We will also argue that one barrier which stands in the way of allowing and requiring front-line workers to be literate at work is an erroneous notion of what certain people, especially "minorities," are incapable of, a deficit way of thinking that has also been the bane of remedial programs in the schools (cf. Hull, Rose, Fraser, & Castellano, 1991).

This work event began one evening during EMCO's second shift while we were "shadowing" a process engineer, Wade (see Figure 3 for the chronology of this event). This engineer, who usually worked during the day, was on special assignment to second shift that evening. We followed Wade about as he made his rounds in the plant, stopping to check with the leads in each department to see if all was well. "Right now, I'm just being available," he told us, "I'm going around . . . just to see how things are going." (Wade understood the notion of shadowing as a way of learning what a person does at his or her job and by then had become accustomed to having researchers around, letting us observe, and explaining his activities.) We stopped to chat with various workers, and Wade, white and native born, made it a point to greet each person in his or her native language. Our last stop was Ely, the lead in the surface mount area, with whom we discussed the end of an assembly project for the plant: Since the process was going smoothly, the manufacture of that board was being transferred to a plant in Singapore. "How 'bout the American people, how 'bout who lives over here, you know?" Ely complained, wishing that EMCO would continue to manufacture the board whose assembly process he had had a part in perfecting. Wade explained as we walked away that it was customary for EMCO to shift its high volume work to its plants in other countries.

Rounds completed, Wade showed us his main project for the evening. One of EMCO's major customers had returned a batch of boards that EMCO had already assembled; these boards were to be upgraded, altered according to the customer's current specifications, and the relevant paperwork updated and approved and appropriately distributed and filed. As explained earlier, this kind of re-work task is common in circuit board assembly, for computer companies are continually improving the design of boards that are already being produced. The challenge for a contract manufacturer like EMCO, then, is to simultaneously maintain production and to update the old boards that have already been assembled—and to do so quickly and accurately.

Figure 3: Chronology of the "Label Problem"

9/22 The TASK: Process Engineer, Wade, sorts a box full of 35 or so printed circuit boards that have been returned from a customer for modifications or "re-work" to bring them up to current specifications

9/24 The PROCESS: Re-work begins; line workers solder, etc., create new labels, affix the labels, and eventually send the completed boards to testing

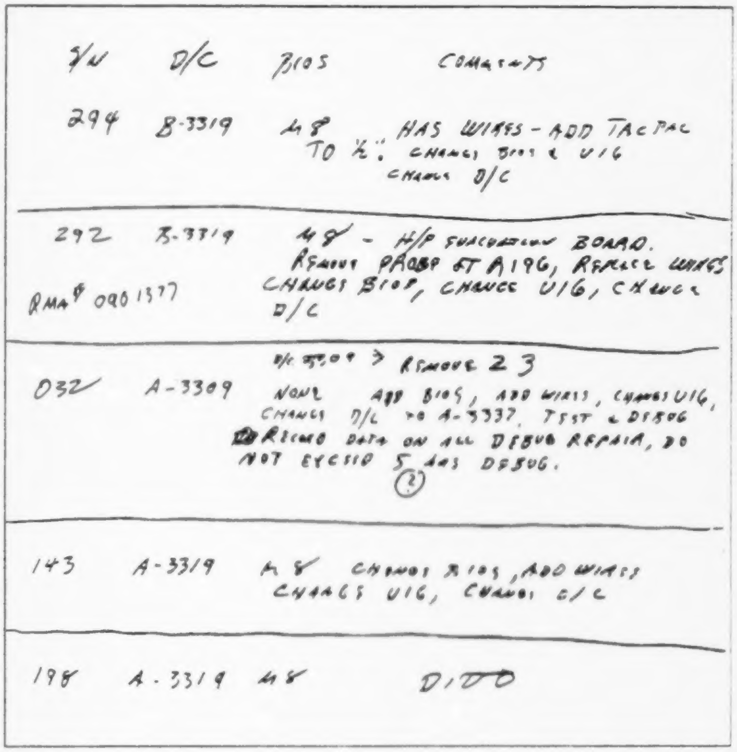
9/28 The PROBLEM: Engineer Wade discovers the boards have been labeled improperly; investigates, talking to the supervisor, the line workers, his boss, other managers; issues a "Corrective Action Report" or "CAR" to the appropriate supervisor; puts other boards on hold

9/29 The SOLUTION: Supervisor meets with workers who did the re-work to "re-train" them; Wade releases the remaining boards to the floor; new labels are made and Wade himself puts them on the boards; boards are released to the testing department

The boards the engineer showed us that evening, which arrived in a batch of thirty-five in one big box, each board worth about $600, weren't all alike; that is, they represented five or six different versions of the same board, each version manufactured at a different point in the design process. Wade therefore had to examine every board singly and sort each into appropriate categories. He made hand-written notes to himself, listing individual boards by their serial numbers, notes he would later convert into instructions for the workers (see Figure 4). He explained, "The operators [employees who would perform the re-work on the boards] won't have to look at it [each board] and try to decide what, which board. Just look at the number and know what (it takes). Checklist." Having completed his sorting and note-taking, he remarked that the re-work would probably be done by a couple of operators and stretched out over several shifts. He said he would check the first couple for "workmanship," but would leave the main inspection for the Test and Quality departments.

During the next week we observed the re-work that was done on a subset of the thirty-five boards, three especially complex "mother boards" that were designated "hot" or high priority; the oldest in the batch, these were the boards the customer wanted

Figure 4: Engineer's Handwritten Notes, Later Revised into MPI for Workers



S/N	D/C	BIOS	COMMENTS
294	B-3319	48	HAS WIRES - ADD TAC PAC TO ½": CHANGE BIOS & U16 CHANGE D/C
292 RMA# 0901377	B-3319	48	- H/P EVALUATION BOARD. REMOVE PROBE AT A196, REPLACE WIRES CHANGE BIOS, CHANGE U16, CHANGE D/C
032	A-3309	NONE	D/C 33.09 > REMOVE 2 3 ADD BIOS, ADD WIRES, CHANGE U16, CHANGE D/C TO A-3337, TEST & DEBUG RECORD DATA ON ALL DEBUG REPAIR, DO NOT EXCEED 5 HRS DEBUG. ②
143	A-3319	48	CHANGE BIOS, ADD WIRES CHANGE U16, CHANGE D/C
198	A-3319	48	DITTO

returned pronto. We observed the addition of a green wire, as directed in the instructions, by one worker, and another worker explained what she had done on the board, characterizing the re-work as "straight-forward" (for the specific re-work directions, see Figure 5). This employee added that all that remained, before sending the boards to the Test department, was the addition of a datecode label (also as mentioned in the directions), and another worker set off to make these new labels.

We saw nothing that struck us as unusual during this process, but when Wade, the engineer, checked on the progress of the boards a few days later as he had said he would, the fur flew. "See the little jumper wires I referred to on the instructions," he had started to say approvingly as he showed us one of the completed boards. Then he paused and noted quietly, "We got a problem here though. The instruction says to make a datecode label of A, 33, 37.... Need to reject these." Jamal, the lead in the Test area, perhaps taken aback by Wade's consternation, pointed to the re-work instructions and said to Wade, "I think this is your instructions." "I know," Wade replied, "and they didn't follow them."

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Figure 5: Excerpt from Instructions for Board Re-Work and Datecode Label Replacement

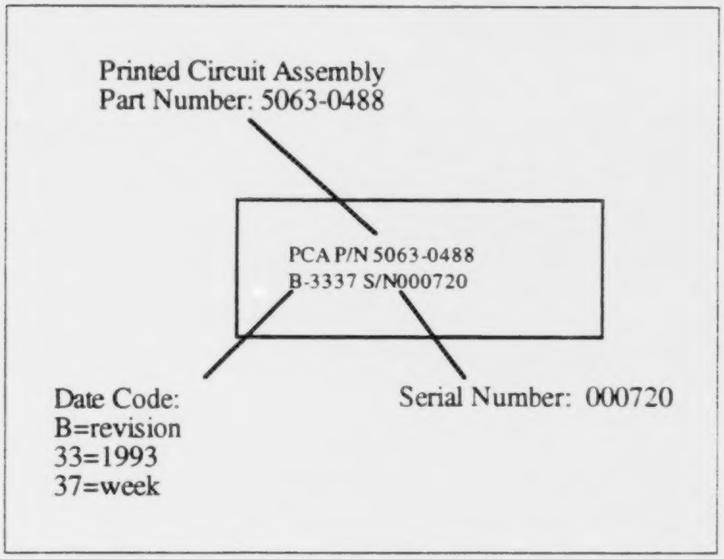
2ND OPERATION
FOR SERIAL NUMBER 032 ONLY, REMOVE DIODE AT LOCATION Z3.
FOR ALL ASSEMBLIES, PERFORM THE FOLLOWING REWORK
REMOVE IC AT LOCATION U16 (74BCT2440).
HAND SOLDER PART NUMBER 1820-6307 (74HCT244) AT LOCATION U16.
LIFT PIN 19 OF U17
LIFT PIN 11 OF U34
CONNECT THE FOLLOWING PINS USING #30 AWG GREEN JUMPER WIRE.
INSULATE LIFTED PINS WITH SLEEVING.
U24 PIN 1 TO U34 PIN 11
U34 PIN 10 TO U17 PIN 19
TACK PAC WIRES EVERY 1/2 INCH.
HAND CLEAN REWORKED AREA
REMOVE M8 REVISION OF THE BIOS IC AT LOCATION U22.
INSTALL M9 REVISION OF THE BIOS IC AT LOCATION U22.
MAKE NEW DATECODE LABEL (A-3337)
APPLY NEW DATECODE LABEL OVER OLD DATECODE ON SERIAL NUMBER LABEL. DO NO COVER OLD SERIAL NUMBER OR ASSEMBLY NUMBER OF THE LABEL.
SEND ASSEMBLIES TO TEST.
TEST
PERFORM ICT IF POSSIBLE AND FUNCTIONAL. RECORD DEBUG TIME SPENT AND ANY REWORK PERFORMED ON DATA SHEETS.

It wasn't that the workers had done the actual repair of the boards incorrectly. In fact, as Wade would later point out, their handwork was so superb that the three boards were virtually identical, just as they should be. Rather, the problem was with the datecode label, a tiny identification that is affixed to every printed circuit board. (See Figure 6 for a replica of the actual label and Figure 7 for an enlargement and explanation.) The parts of the label include the date code (which indicates the version of the board—in this case "B"—and the week and year it was manufactured—in this case the 37th week of year 33, meaning 1993) and the serial number, the unique identification number for that particular board. Wade's instructions had directed the workers to first "Make new datecode label (A-3337)" and then to "Apply new datecode label over old datecode on serial number label." He further directed, "Do not cover old serial number or assembly number of the label" (see Figure 3). The workers' mistake was threefold: They had removed and discarded the original label; they had generated a whole new datecode label with a new serial number; and they had changed the version number on this new label from A to B.

Figure 6: Datecode Label: Actual Size

PCA P/N 5063-0488
B-3337 S/N000720

Figure 7: Datecode Label: Explanation of Parts


Printed Circuit Assembly
Part Number: 5063-0488
PCA P/N 5063-0488
B-3337 S/N000720
Date Code:
B=revision
33=1993
37=week
Serial Number: 000720

Upon discovering the mistake, the engineer hurried down to the shop floor to find out what had happened. He called to the lead in the "second operations" area:

Wade: Marisa! (pause) RSD madre?

Marisa: Yes.

Wade: RMA's?

Marisa: Right.

Wade: Did you make the stickers?

Marisa: The sti, yes.

Wade: Day shift? Porque no A? How come there's no ( ) serial number? (What did you do with the old) serial number? (Did you just) put new serial number for everything? Why did you-

Marisa: -I don't touch those. Who was the person?

At this point, visibly alarmed, Marisa went to seek reinforcements from among the operators who worked on the three boards, and they spoke together in Spanish for a moment, but nothing seemed to be resolved. Wade then instructed Marisa:

> You're getting 30 more RMA boards out here. We have to know what serial number it is.... Looks like somebody took the old serial numbers off them. Now we can't tell what serial numbers they are. Now we got problems. They're gonna be on hold until I have time to check 'em out. Make sure this doesn't happen on the rest of them, okay? I need to go talk to Celia [Marisa's supervisor].... Gracias.

With this, Wade strode off to break the bad news elsewhere.

The researchers were still somewhat mystified by the degree of consternation that accompanied the label problem, for surely, we thought, the labels could simply be reproduced and the error corrected. But this was not the case. As Wade explained, several times over the course of the next half hour:

> (To the researcher) Now we've lost traceability on these boards. (pause) Basically I don't know how I can identify them now.
>
> ....
>
> This is kind of serious because it's an irretrievable thing that you can't really fix.
>
> ....
>
> (to the Quality Engineer) This is, this is kind of serious because the traceability is important and now we've lost it.

The concept of "traceability" is central to EMCO's successful dealings with its customers. As a contract manufacturer, the company must keep exact records on all their products, including recurring updates and modifications, and the record-keeping applies to individual boards as well as to types of products. In this case, the three mother boards had been taken out of particular systems, and the customer expected to replace each board accordingly. (The program administrator in charge of this particular customer toyed only briefly and fleetingly with the idea of a cover-up: "So now what do we do? We could fake it, we could fake it, but that would come back to haunt us.") It is significant, and we will return to this point later, that "traceability" is inexorably linked to literacy: It is a literate practice that some employees at EMCO share and understand and that others don't, despite the fact that it has implications for the work of almost all.

In addition to trying to understand the significance of the mistake, we were interested in why it had happened, especially since the error was apparently connected to workers' failure to read, understand, or follow written instructions. When we asked Wade how he thought it had happened exactly, he responded:

Wade:	Probably related to another acronym we have here, "OBD."
Researcher:	I hesitate to ask.
Wade:	It stands for "operator brain dead."
Researcher:	Uhh-oh.
Wade:	Occasionally we run into that, not too often.
Researcher:	Yeah, yeah.

When he described the problem to Frank, a fellow engineer, Frank observed that the operators must not be reading the instructions. Wade replied: "Well, they may be reading them, but they're definitely not following them." Later in the conversation Wade complained: "We've got to make them [the workers] understand that maybe they should read these things and follow them. I don't do them [write the instructions] just to justify my existence." "You don't?" Frank asked teasingly. "I'd be in big trouble if that's all that justified my existence," Wade shot back. Apparently, Wade wasn't sure whether workers had failed to read the instructions or had read them and failed to follow them; but it was six of one and half a dozen of another to him, and in any case an example of the malady he referred to several times as "OBD."

Having broken the news to the shift supervisor (who would need to speak to Marisa and the other workers about the problem) and the program administrator (who would need to inform the customer), Wade spent the next hour dealing with the label problem. His concerns were several: the remaining thirty boards yet to be re-worked, which he feared were destined for the same labeling error; the detective work he might be able to do to distinguish the 3 mislabeled boards; and the paperwork required as a disciplinary action.

Wade began to consider early on whether and how and to whom to write a "Corrective Action Request" or CAR. He explained that CARs had been instituted a couple of years earlier at EMCO, and at the outset so many of them had been issued that people joked about having "CAR Wars." However, CARs were intended for serious and/or recurring problems. He thought aloud about the problem of issuing this admonishment:

> Now when I talk to Celia [the day shift supervisor] I've got to verify which shift this happened [on] if I want to do a Corrective Action Request (to know who to address it to). If I can't determine which shift it happened on, I have to go to the next higher level, Ed Fancher [the production manager]. Address it to him so that he can (deal with it). Thing is, Ed Fancher's on vacation, so my boss is Bill Jorgeston ( ). Have to be careful when you give your superiors Corrective Action Requests; they don't like to receive them.

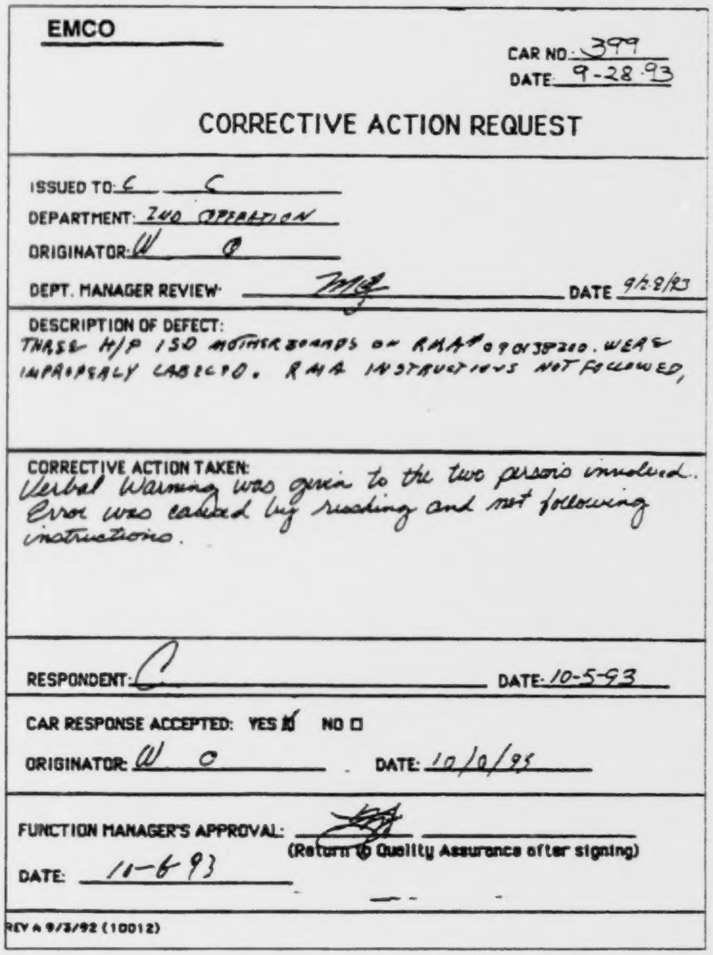
He also sought advice from Frank, his fellow engineer: "I think that's [the label mistake] CAR material. What do you think? It's serious, it's irretrievable. Now I got these boards, I don't know which one's which." Frank advised Wade to send the CAR to the supervisor but before doing so to have the required discussion: "Procedures says you're supposed to talk to them before you issue the CAR, supposed to discuss it." Thus, Wade called the supervisor, explained what happened, and told her he would have to issue a CAR directed to her. And before he left for the day, Wade wrote the CAR to Celia the supervisor (See Figure 8), and he made it short and sweet. Pointing to what he had written, he explained:

> This is gonna state that the motherboards that came in, the RMA boards, were improperly labeled, and they didn't follow our instructions. That's basically what the defect was, they didn't follow instructions. I don't think I really need to expound, "Because of this we lost traceability" and do a description of the defect. They were improperly labeled."

It is interesting here that, after expounding a great deal to several people about losing traceability, Wade made the decision not to identify the significance of the mistake in the CAR.

Before leaving for the day Wade examined the three mother boards again and came up with a way of distinguishing them (through a separate date stamp and then by process of elimination). This meant that the customer wouldn't have to be notified and the mistake could be corrected the next day with no harm done. The next morning Celia met with the workers on her shift to discuss the mistake and figure out how to prevent it; she then responded in writing to Wade's CAR (see Figure 8, "Corrective Action Taken"). Wade directed the workers to reproduce the old labels and to generate the new labels. "Bonito?" Marisa asked, as she presented the new labels to Wade. "Perfect! Muy bonito," he answered, and then he pasted the labels on the boards himself and released the remaining boards to the floor.

Figure 8: Wade's Corrective Action Request (Including Celia's Response)



EMCO

CAR NO: 399
DATE: 9-28-93

CORRECTIVE ACTION REQUEST

ISSUED TO: C C
DEPARTMENT: 2ND OPERATION
ORIGINATOR: W O
DEPT. MANAGER REVIEW: DATE 9/28/93

DESCRIPTION OF DEFECT:
THREE H/P 150 MOTHERBOARDS ON RMA#090138210. WERE IMPROPERLY LABELED. RMA INSTRUCTIONS NOT FOLLOWED,

CORRECTIVE ACTION TAKEN:
Verbal Warning was given to the two persons involved. Error was caused by reading and not following instructions.

RESPONDENT: C DATE: 10-5-93

CAR RESPONSE ACCEPTED: YES ☑ NO ☐
ORIGINATOR: W O DATE: 10/10/93

FUNCTION MANAGER'S APPROVAL:
(Return to Quality Assurance after signing)
DATE: 11-6 93

REV A 9/3/92 (10012)

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Beyond Deficit Thinking: Why Didn't the Workers Read?

In order to move beyond simple assumptions about deficiency in individuals and groups and towards broader-based explanations which take into account institutional, social, and cultural contexts, and which can offer different solutions, we explored a range of explanations as to why workers didn't read or follow the written instructions concerning the datecode label. We did so by interviewing employees up and down the plant hierarchy, including the operator who actually applied the incorrect labels.

We've already heard from Wade, the engineer, an explanation that the workers were "brain dead," just not paying attention at the moment. This view was, however, inconsistent with Wade's overall characterization of the workers as competent, even too competent: When trying to distinguish the three boards one from another, he noted that the re-work was so finely done that he couldn't tell the boards apart through physical evidence. And at various times he offered other examples of their expertise.

Another possible explanation, one that perhaps would occur most quickly to literacy specialists, is that the text that workers were expected to read was unclear, ambiguous, or vague. And in fact, the program administrator offered this explanation when he first heard about the label problem, albeit jokingly:

Rod: So this must reflect on the instructions provided by the, uh, the engineer, I guess the cognizant engineer.

Wade: I keep telling you I'm not cognizant. [more quickly] You've got the instruction that says in there-==

Rod: ==Yeah, yeah, don't cover up the old number. So now what do we do?

Since Wade was responsible for writing the re-work instructions, Rod couldn't resist the chance to tease him about his prose. And surely, the instructions (see Figure 5) could have been worded more clearly. It is also important to note that the front-line workers weren't allowed to construct or alter manufacturing process instructions themselves, these most important of factory documents, so they were continually at the mercy of Wade's prose and that of other engineers. Incomplete or inaccurate instructions were something we heard many complaints about, although the workers grew accustomed to deciphering or to working around the inadequacies of such instructions on a daily basis.

Another interpretation that relates to language has to do with the fact that this was a largely immigrant, in fact largely Korean workforce. The perception was that most of the Korean workers and many of the other immigrants could not speak English, could not understand English, could not read and write English, and furthermore, that they weren't all that interested in learning. "What could help us here," said one manager, "is an intense ESL program. The Koreans would resist that—my impression—none of 'em ever said that. I just have this feeling they wouldn't be receptive. The women were going to ESL class and for some reason they just discontinued that."

In fact, some of the Korean women were so interested in learning English that they were attending a literacy program especially for Asian immigrant women after work in a different city some miles away. Here is what Sook Yoo, one of those women, had to say (through an interpreter) about not speaking English well:

> I think there is a reason why we don't speak English that well. When we started working at EMCO, our starting pay was so little. But since we didn't speak much English, we just took the starting pay. We started working and stayed for a while, but since the pay was so little, there was no time for us to study, realistically, because the pay was so minimal.... And we were so busy trying to survive. Since we came up that way, even now, we don't have a lot of money, and we are leading a hard life.

Sook Yoo and the other women in the literacy class went on to explain that in their community Koreans don't like to get help from the government, that they want to earn the little that they get. This, plus the value they place on higher education for their children, often necessitates their taking two jobs. The result is too little money, too little time to learn English. Not being able to speak English, they pointed out, means not being able to defend yourself in the workplace when you're accused of a mistake, and most importantly, it means a greatly reduced chance of promotion, even when you do your current job very well. There are no Korean supervisors, they observed, in this high-tech workplace where international certification standards require that manufacturing process instructions be written, read, and communicated in English. They wished that the company had continued to provide English classes on site, but these classes had suddenly been discontinued. Sook Yoo concluded: "So we lost the chance to learn English, and now we are too old."

The manager was right, then, that there certainly were some workers, mostly Korean, who didn't speak much English, but he was way off base in assuming that they didn't want to learn. We should also point out that it is not necessarily the case that workers who don't speak much English don't understand much. Over and over we've found that workers in factories like EMCO understand much more than is apparent. As one employee put it, many workers "cannot speak nice, but understand." Further, in our fieldwork at EMCO and Teamco, we have regularly observed workers translating for each other; indeed, leads for the various areas and lines at EMCO are chosen in part because they are bilingual and can serve as literacy and language brokers. At this factory, and at countless others in the Silicon Valley, immigrants with limited English skills meet their companies' quality and productivity goals everyday despite the fact that not all of them speak, read, or write English well. We are not arguing that things wouldn't be easier overall if everyone in a plant spoke and was literate in the same language, but that work generally gets done quite competently even when this is not the case, especially in traditional forms of work organization, as was the case at EMCO. We shouldn't, then, automatically assume that limited English was the reason the three boards were mislabeled.

Let us turn now to explanations provided by employees who worked on the shop floor. The first shift supervisor, Celia, on whose watch the label problem occurred, believed her workers read the instructions too quickly to notice what was salient, and that they did so because they were mistakenly in a rush to finish the boards so that they could be moved to another department:

> They know that they have to read. Each RMA [re-work instructions] is usually always different. In this case, they read it, but read it so fast that they didn't comprehend everything that was needed to do, so they missed it.
>
> ....
>
> They feel like it's a shift type of thing. They need to produce enough assemblies. Whatever they touch and work on, they need to move it on to Test. It's a quota type thing. It isn't.

Thus, this supervisor attributed the label error to another error, the workers' belief that if any boards were waiting for them on their shift, they should be moved on to the next step in the manufacturing process, to the next department, as quickly as possible. (See also Figure 8, which includes Celia's response to the engineer's Corrective Action Request.) Although this supervisor made a point of insisting to us that quality was most important, and that the workers were wrong in thinking that there was some kind of quota they needed to reach on a given day, our research team observed plenty of instances in which workers felt pulled in two directions—high quality versus high productivity. "Push, push, push," one worker said of another supervisor's modus operandi. At Teamco the complaint is similar: How can I keep my quality high if I must work faster and faster? Thus, this tension is a fact of life that workers have to cope with, even when it remains unacknowledged, and conceivably, it could have had something to do with the label problem. But let us ask the workers themselves.

Marisa, the lead in the hardware department, is the person who made the incorrect labels and passed them to another worker, Tran, to be affixed to the boards. She commented first that "It's too bad that you [the researcher] have to find out about these boards. We are not supposed to make mistakes like that." She had several explanations for the problem, the first resembling the supervisor's analysis in that it also focused on time—that work that day had been hectic: "It was so busy that day...and besides they tell me, 'Oh, we have these three boards' and they said 'we need to ship these three boards.'" Clearly, Marisa thought the boards were "hot," that they had to be shipped pronto, so she may have given the written instructions short shrift. She also pointed out that the worker who actually pasted the labels on the boards, Tran, was new, and that she hadn't had time to train him sufficiently. Next time, she predicted, she would have an experienced person work on the special boards.

Marisa's other explanation had to with how work was organized on the floor, especially the literacy requirements of work. It seems that one worker in Marisa's department, Mrs. Kim, always read the entire set of instructions for each board and let people know if anything special was required. On the day the three mother boards were re-worked, Mrs. Kim was absent, and the person who took over her job did not act as the literacy broker for the rest of the workers. "She just read her part," Marisa complained. "Mrs. Kim always reads the *whole* thing and then she tells you." Not alerted to the special directions, Marisa made new labels according to the customary process.

Interestingly, if Marisa had read the instructions herself, she would certainly have known what to do in a procedural sense—to leave the old datecode label on the board, to prepare a new, smaller label with a new month and year, and to paste it on top of the old one. Marisa would also have understood that the process was done this way because the customer wanted it done this way. However, as will be clear from the following excerpt, she would not have understood the role and importance of such documentation in the all important practice of maintaining traceability:

Researcher: Do you have to understand what the numbers [on the label] mean?

Marisa: Yes, this is the datecode. We're supposed to leave old label. Customer wants to change new datecode. I make small label with datecode and cut it and put it on top of the other one.

Researcher: Why is that so important to the customer?

Marisa: We're not supposed to remove the old label. That one, we're supposed to leave it on there.

Researcher: Do you understand why they care that much about whether the old label's there?

Marisa: Uhhhmm, not really, but we just have to follow what the customer wants if he, they say "I want you guys to remove that label, we just want to leave it alone, just change datecode."

Researcher: Do you understand why it's such a big deal?

Marisa: I not really understand that.

It is quite significant, we would argue, that workers like Marisa were expected to read and follow directions, but not to understand their significance. This suggests another reason for the error, not having access to global knowledge about the manufacturing process that makes tasks understandable, meaningful. If Marisa had understood the relationship between labels and traceability, and if she had understood the role of traceability in contract manufacturing, she might have paid more attention to instructions to make particular datecode labels.

The last worker we interviewed about the board problem was Tran, the person who had pasted Marisa's incorrect labels on the board. His explanation for his part in the mistake was simple—reading directions was not part of his job:

Tran: Only the lead take care.

Researcher: Only the lead takes care?

Tran: When I'm not lead, I'm not looking.

Researcher: Not looking at the MPI? [Manufacturing Process Instructions]

Tran: Yeah. Only the lead take care.

Researcher: Did anybody ever show you how to read the MPI?

Tran: No, they didn't show.

Even as a new employee Tran recognized what we had learned from the managers early on in our study: EMCO's policy was that only the leads for each line or area are responsible for reading written instructions; these leads are then supposed to spread the word orally. As we saw with Marisa, sometimes the people in an area work out a system whereby someone besides the lead is the literacy broker. But the official policy—which originated in large part as an attempt to compensate for what were perceived to be ESL problems especially among the Korean workers "who weren't keen on learning English"—was that only the leads were required to read. Thus, Tran, who could read English and who could have read Wade's re-work instructions, didn't feel compelled to do so, and couldn't be blamed for his choice, given EMCO's policy on literacy responsibilities.

The work event on mistaken labels, and our subsequent analysis of the possible reasons for this mistake, suggest that it may indeed matter, and matter a great deal, that work is organized such that front-line workers aren't supposed to read. It would seem that, not only should front-line workers be expected to read, but they will also need to possess a greater knowledge of the plant's operation and the industry's practices if they are to interpret accurately what they will need to read. Thus, being fully literate in such a manufacturing environment goes beyond being able to decode instructions on how to apply a datecode label, and includes as well global knowledge of the industry—such as understanding the important practice of traceability.

The labels event illustrates, further, how erroneous beliefs about ability, beliefs which most likely grow from ethnic or class bias, can have a harmful influence on work organization and work relationships. We recall one EMCO manager's opinion that the Korean workers would mysteriously resist ESL instruction. The following is a more blatant statement that such workers are different and lesser, this assessment by a personnel supervisor who characterized the largely Korean, immigrant workforce of the factory in opposition to the factory's largely white management:

> Yeah, well see, most of those people are, have only been in this country less than ten years. So most of those people are your craft kind of people, your general assembly labor, and that's about all that they *want* to be....'Cuz you figure, you, 'cuz you know, we have like two classes. We have our worker/assembly people and then we have like our supervisor/manager/engineering kind of people, and it's, it's, there's really like two ends of the scale. We've got people that almost can't communicate and you have people on the other end with like degrees.

Such a dichotomy, a great divide that generally separates labor and management aided by the absence of respect on either side to bridge it, is no doubt familiar to anyone who has spent much time in industrial America. Feeding this division is a long-standing tendency on the part of many in our society as well as throughout history to view skeptically the abilities of people who labor physically, "sentiently" rather than "intellectively" (cf. Zuboff, 1988).

Considering working Americans—those people EMCO's personnel supervisor designated "your craft kind of people"—as somehow lesser in ability and potential is wrongheaded in many ways. To slide too quickly to labels like "OBD" as explanations for literacy-related or other errors, to form stereotypes based on the intersection of ethnicity and class and gender, is to obscure explanations that may be closer to the mark and that may improve a company's functioning as well as more justly represent the abilities and potential of workers. To resort to such labeling also mischaracterizes the kind of support that workers need to improve their performance, to eliminate the errors that so vex their supervisors, engineers, and managers.

By examining Wade's labeling problem from a socio-cultural perspective, we are able to infer that carelessness or a simple lack of attention was far from an adequate explanation for why the workers failed to read. Rather, a complex web of contextual factors combined to create the conditions under which such a mistake could happen. There was, at root, the mistrust that permeated managers' thinking concerning their largely Korean workforce and these workers' perceived ESL problems and their lack of desire to learn English. The managers' erroneous assessment influenced the very organization of work; that is, the company's policy was that only leads, one designated person per area, need read the important manufacturing process instructions, and this despite the preponderance and importance of documentation to the company's relationships with its customers and international certification agencies. Similarly, and just as significantly, front-line workers weren't expected to have certain kinds of knowledge about the company's functioning as a contract manufacturer. While talk about "traceability" was common among higher-ups in the company, as well as an understanding of the role of literacy in this process, including the simple but essential literate practice of affixing datecode labels, front-line workers like Marisa did not share in this knowledge. And the company almost suffered for it.

Thus, we would suggest that EMCO's mistrust of its immigrant workers' language and literacy abilities coupled with the conflicting pressures of a contract manufacturer to produce at high quality and in high volume resulted in language and literacy policies and practices that took away from most front-line workers the responsibility to read manufacturing process instructions as well as the felt need, the opportunity, and the desire to do so. Being literate in English and being an English-speaking employee was not part of the work identity of most Koreans and many other employees.

EMCO: A Third Work Event

Obsolete Documents and the Limits of Authority

We stated earlier that EMCO claims to have adopted some of the practices associated with "high performance" work organizations, such as self-directed work teams. We also quoted the plant manager, who spoke about "the need to create a culture where people believe that they can make decisions without being put in a penalty box," and his belief in decentralized decision-making and self-directed work teams—but only for managers. And we asked, after we had presented an introductory re-work event, whether it really matters that EMCO is in actuality a traditionally organized workplace. Does it matter, we wondered, that there are no formal occasions for line workers to make suggestions about the process or organization of their labor? Do workers really experience any lack of "empowerment" at EMCO, and if so, do the plant's structure and the relationships that this structure engenders affect day-to-day work practices in a negative way? Our answer is yes, and in the following work event we will demonstrate this, and we will highlight as well the ways in which literacy is implicated in EMCO's work organization.

This work event centers on Eduardo, who appeared briefly in the re-work event earlier. We will recall that Eduardo is Filipino and has a BS in mechanical engineering from the Philippines. He had worked for ten years in his native country in supervisory and management roles for an oil refinery, an explosives manufacturer, and a glove manufacturer. When he and his wife came to the United States in 1988, he discovered that "Whatever education we got in our countries ... is not recognized here in America." After sending out nearly 50 applications in his first month in the States, and being told he either had the "wrong" education or was over-qualified, he found a job in the electronics industry doing mechanical assembly.

"The first time I got my job here," he told us, "there is a shock on me. The kind of job I am doing before, I'm handling people, I let those guys do the work for me for the company. And now ... I'm doing that simple kind of stuff. So it's really a, shall I say, disappointing one?" Eduardo, having worked in electronics for nearly six years now, is a lead in the hardware and Touch-Up areas of EMCO, where he alternates between screwing brackets to boards and carrying totes of boards between workers and the wave solder machine. He has worked there for a little over a year, earning from eight to ten dollars an hour.

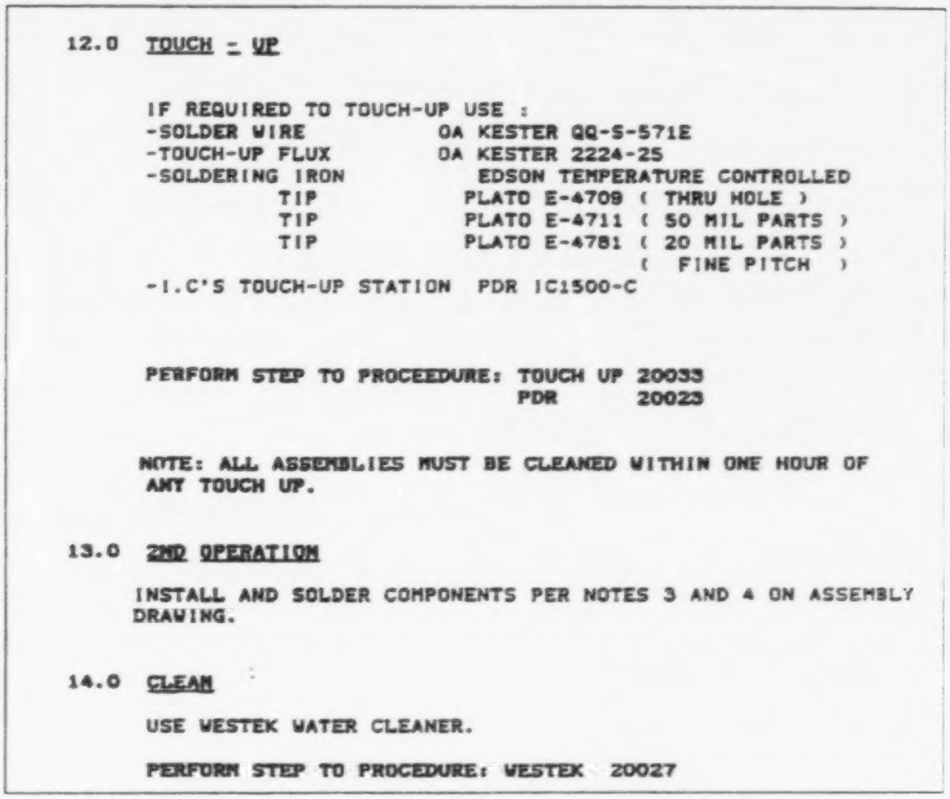
"I want to not stay here for so long, doing this kind of job," he told us. "I need to grow in the company. Maybe transfer to other department, maybe Test. And maybe I could be a machine operator if they give me a chance. But I don't get that chance, not really, not yet by this time. Not really. I really need challenge, you know. I don't want most of the time doing this kind of job. I don't feel challenged in this kind of jobs." Eduardo is a proponent of quality circles, continuous improvement, and self-directed work teams, and, as we will later hear, he chafes in this particular factory where teams are reserved for managers and engineers.

Eduardo hopes to go back to school and study "whatever will be the best for me." But those plans will have to wait because, as he says, "right now I have a family, I have little kids to take care of. My youngest son is only four months and a half. So maybe when my youngest will be grow old, maybe five years old or six years old, maybe that's the time that I'll have some extra time. When I send him to school, maybe I go to school also." In the meantime, Eduardo continues to work swing shift while his wife works days at another electronics firm.

Now let us return to the factory floor of EMCO; we are back on second shift with Eduardo. In this work event Eduardo is facing a problem that is not uncommon among contract manufacturers in this industry. His department has received some old circuit boards from a customer, thirty-six boards to be exact, a rather small run (which is not unusual but which means he also has several other projects to attend to, some bigger, some smaller). The workers are supposed to update those boards by soldering some components onto them; this is an old board that is still manufactured for a special calculator that was developed in 1979, so during that period it is likely that the board itself or the components have changed. Eduardo's job is to figure out, by reading all the documents and examining the sample board and checking the kit, exactly what should be done to it, with what parts, in what order. Significantly, he is the only front-line worker in his group who is required to read the MPI, or manufacturing process instructions, which makes him a literacy broker of sorts. After he has figured out what to do, as the lead worker in his area, he will explain it to the rest.

To carry out this task, Eduardo has, as he soon realizes, some inadequate written instructions (Figure 9, point 13); an obsolete drawing (Figure 10)—the numbers on the drawing have changed and so have the shapes; and a bill of materials, or BOM. As is his usual procedure, Eduardo compares the written texts with the components in the kit, pouring over a variety of forms of representation for a while, and it is then that he realizes that they don't match. That is, the components don't look like what the drawing says they should look like, and in fact, attaching them to the board presents some technical problems. (For instance, the drawing indicates that a component is supposed to be attached to an oblong component and grounded to a rivet. But this requires a longer ground lead than was provided in the kit.)

Figure 9: Excerpt from MPI Outlining Eduardo's Tasks (Step 13)



```
12.0  TOUCH - UP

      IF REQUIRED TO TOUCH-UP USE :
      -SOLDER WIRE           OA KESTER QQ-S-571E
      -TOUCH-UP FLUX         OA KESTER 2224-25
      -SOLDERING IRON           EDSON TEMPERATURE CONTROLLED
                TIP            PLATO E-4709 ( THRU HOLE )
                TIP            PLATO E-4711 ( 50 MIL PARTS )
                TIP            PLATO E-4781 ( 20 MIL PARTS )
                                            (  FINE PITCH  )
      -I.C'S TOUCH-UP STATION  PDR IC1500-C


      PERFORM STEP TO PROCEEDURE: TOUCH UP 20033
                                  PDR      20023

      NOTE: ALL ASSEMBLIES MUST BE CLEANED WITHIN ONE HOUR OF
      ANY TOUCH UP.

13.0  2ND OPERATION

      INSTALL AND SOLDER COMPONENTS PER NOTES 3 AND 4 ON ASSEMBLY
      DRAWING.

14.0  CLEAN

      USE WESTEK WATER CLEANER.

      PERFORM STEP TO PROCEDURE: WESTEK  20027
```

At this point Eduardo tries to flag down Wade, the engineer assigned to this project, to ask him about the discrepancy. After all, it is the engineer's responsibility to update old assembly drawings. But it is the end of day shift and Wade is on his way out the door. He gave Eduardo short shrift, simply telling him to "lap solder" the wire or attach another wire to the ground lead, which, Eduardo believes, wouldn't provide the most reliable connection. Next Eduardo goes to another part of the factory where parts for old boards are stored to see if the customer provided a sample board to go by. And sure enough, there is a sample board, but it is plugged into a system, and Eduardo is told he will need to get permission from the person who oversees that area to take the board. That person is unavailable. So Eduardo looks at the sample board without taking it out of

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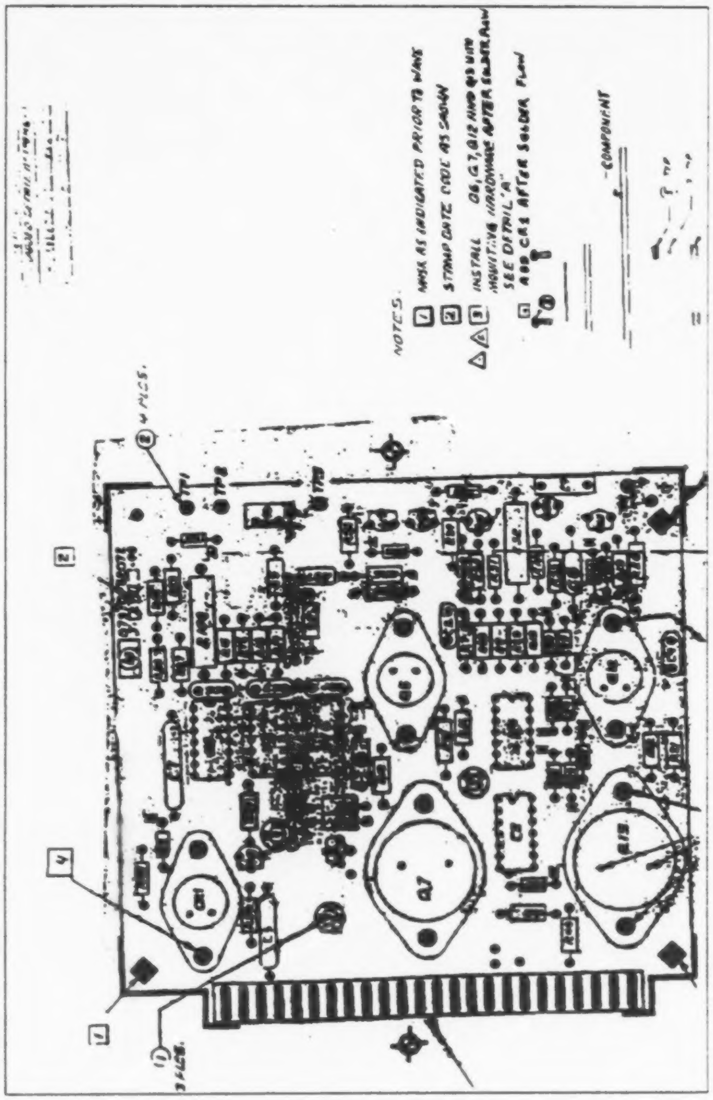
the system that it's hooked up to, and he constructs his own drawings of it (Figure 11) and his own parts list (Figure 12) on scraps of paper as best he can.

Figure 10: Obsolete Assembly Drawing


NOTES:
1 MASK AS INDICATED PRIOR TO WAVE
2 STAMP DATE CODE AS SHOWN
3 INSTALL Q6, Q7, Q12 AND Q13 WITH MOUNTING HARDWARE AFTER SOLDER FLOW
SEE DETAIL "A"
ADD CR1 AFTER SOLDER FLOW
COMPONENT
4 PLCS.
Q7

He then goes to the office of his supervisor, a woman named Maggie (whom we also met in the earlier event), spreads out all the drawings and components, kneels down beside her, and they both hold the board that needs to be modified and talk their way through the problem. They're very concerned about how to get that component soldered

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on properly, and they go back and forth about whether it would be all right to tilt it so as not to have to attach such a long lead line; they both disagree with the engineer's solution of a lap solder. The supervisor keeps pressing Eduardo toward a particular solution to the problem, but he persistently doubts that it will work, partly because he is unsure of the drawing he had made so quickly and partly because he feels that he doesn't have the written authority through manufacturing process instructions to proceed and partly because the supervisor doesn't seem so sure about what to do either. Finally, after manipulating the component, situating it this way and that on the board for approximately six pages of transcript, the supervisor asks to see the official documentation, realizes how inadequate it is, and joins Eduardo in complaining about Wade, who should have updated the drawing and provided sufficient instructions and thereby given them the authority to do their work, but didn't.

Figure 11: Eduardo's Impromptu Assembly Drawings

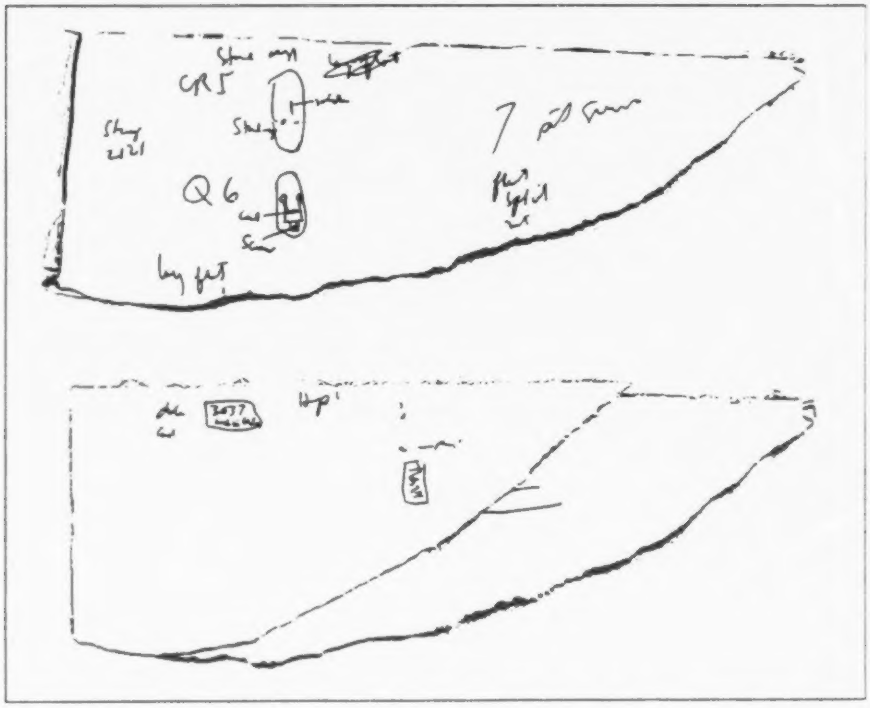
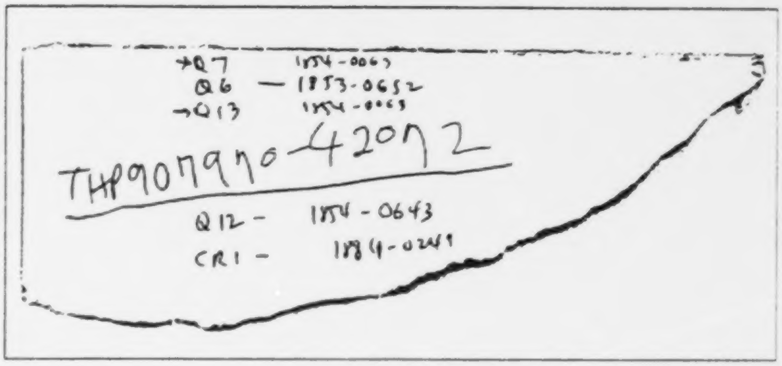


Figure 12: Eduardo's Impromptu Parts List



→Q7 1854-0063
Q6 — 1853-0652
→Q13 1854-0063
THP907990-42072
Q12 - 1854-0643
CR1 - 1884-0249

Maggie finally decides that Eduardo should go ahead and put the components on; they will curve the lead to get more length out of it, but as Eduardo argued, they won't tilt the component. But just to be sure, because they don't have written authorization—a deviation approval to do it this way—they will contact the program administrator, Rod (the engineer's boss), whose name the supervisor notices on one of the documents. They recognize that Rod doesn't know much about manufacturing, but they feel the need for someone's approval. " I hope my eyes serves me right when I look at this part," Eduardo says a little nervously as they wait for the program administrator to appear. At this point he reaches into the pocket of his smock and pulls out a few scraps of paper on which he'd made quick drawings and notations (Figures 11 and 12). He explains his solution, looking at his drawings, and recaps his process, as Maggie and the researcher admire his inventiveness:

Eduardo: Standing up like this. And the solder on the two, on the two legs, and then (...) solder on the side, and this one should be, should be laid flat. Just put a screw there, and then tuck this in the middle, then solder on both sides, left and right. But this one-

Maggie: (laughs)

Researcher: This is good. Eduardo's, Eduardo's MPI [Manufacturing Process Instructions], right here, huh?

Maggie: That's his shorthand!

Researcher: Yeah. I like that.

Eduardo: But I try to figure out, because the board's-

Maggie: I love it.

Eduardo: -because the board is right here, plugged in, in the system

Researcher: And they won't let you take it down.

Eduardo: They won't let you take it out. And the drawing is-

Maggie: The drawing is obsolete.

Eduardo: I just try to be resourceful, you know, out out of the blue, that-

Eduardo goes on to complain again a little bit about Wade's sloppy documentation: "MPIs not updated, and handwritten, but it should not be. It's against manufacturing operating procedure.... But they let it go like that, they want to happen like that, you just have to be an ME [Manufacturing Engineer]...."

The program administrator arrives with an enormous red three-ring binder in his arms; it is supposed to contain every single document about this project, its history, all of the communication with the customer, the MPIs, the material transfers, the deviations, etc. Maggie gives Eduardo permission to explain the problem, and Rod flips through his big notebook to see, in his words, "if I have anything in writing on this." Rod can't find permission from the customer to change the board in the ways Eduardo has outlined, but he says he may have seen such a letter on someone's desk at some point, and they should go ahead with the work. Eduardo asks if he can look one more time at the sample board that is now in a locked department, and Rod agrees. Everyone walks to the "support maintenance lab," the department where a variety of older projects are maintained. The security guard opens the door, and Eduardo looks at the board and announces immediately and with satisfaction, "I did the right drawings." Rod leaves a note saying that he has signed out the board to Maggie, and Eduardo takes it away to refer to in making his own sample. Rod directs them to do the work and promises that he will look for the authorization, and if he doesn't find it, he says that they can consult the engineer in the morning.

Eduardo makes a new sample board, manipulating the new parts according to the earlier discussions, his drawings, and the customer's sample board. Maggie the supervisor approves his sample and celebrates their having solved the problem. "Yeah, looks good," she says. "Very good. Heh heh heh heh [dramatic voice] And nothing stops us, even on swing shift. Dun-dun-dun-dun." Almost an hour has elapsed since Eduardo first discovered the discrepancy between the written instructions and diagrams and the task at hand. He can now return to the floor and instruct his workers on procedures for the board. Maggie, meanwhile, makes note of the problem in her passdown to the day shift supervisor.

Eduardo's Work Event Revisited, Or Literacy as a Measure of High Performance

It is interesting and troubling to note how greatly the EMCO manager's rhetoric about being "high performance" conflicted with the experience of the front-line workers (and, as we will see, of some managers, too). In the above work event Eduardo feels totally unempowered to make decisions at virtually every step of his very competent problem-solving process, and in fact, exceedingly frustrated that he must waste an hour to get approval through the most contorted means for a solution he could have arrived at on his own in a matter of minutes. It's quite ironic, then, that Eduardo is a proponent of problem-solving teams, quality circles and other management strategies which involve front-line workers in decision making. He often expressed to us his frustration at the lack of structured opportunities in this plant for workers like him to provide input on how work gets done. On one of those occasions, we asked him if he'd ever talked to the Quality Engineer about trying to establish a regular team meeting. He replied: "No. That point is, uh, I'm not, I don't know if I have the re-you know, the prerogative to talk to those guys [the line workers] because basically what my point is, uh, she is my boss, the supervisor. Any idea should go through her." When we reminded Eduardo that his supervisor Maggie had actually called one group meeting on her shift, Eduardo was skeptical: "You know my, my humble assessment is these guys never, Maggie's going down here, 'Push, push, push.' These guys are scared. These guys are scared. In the meeting? You see in the meeting? Instead of talking, or, they just keep quiet. Some of these guys they just keep quiet." Thus, Eduardo believed that it was inappropriate for him to make suggestions over the head of his supervisor, and he also noted that most people felt fearful about speaking up and would be unlikely to make suggestions even if there were a forum.

Eduardo's frustration was echoed by other line workers. Here is Ely, the lead in the robot department, boiling over because he has been asked to do a clean-up task that he believes could have been avoided:

> Sometimes you get mad. You know something is wrong, and then you just do that also, you know you are a part of it, making mistakes and it's sad. And people, they don't communicate and even though you tell them, you know, I give up. You know, before? When I came here, in the first year, to SMD [Surface Mount Department], I tried, you know, emphasizing what I, what is better.... Oh my god, you know, what am I doing... I look like I am the bad boy, just telling them problems. Now my middle name is T, Mr. T, Trouble. Engineers, that's what they call me. "Here we go, Trouble, now what is it?"

Ely gives an example of how he knew the line should be set up differently so that certain machines are closer together—"instead of having to walk eight hundred miles," he said, laughing, "sometimes you need a bike." But he claims that no one will listen to his suggestions and added scathingly that "they [managers, engineers] don't realize twelve minutes, that matters in production."

Interestingly, the line workers weren't the only ones to complain to us about not being heard. So did the engineers, albeit in a different way. They acknowledged that they were asked to make, indeed expected to make decisions, but everyone knew the decisions would have to be approved, that in effect they weren't real decisions. As one engineer put it, referring to the plant's managers, "The five white guys want to 'empower' us, but they don't want to, they don't want to give us full control."

In his current position, Eduardo says that he is "just a worker" who has to rely on a formal chain of command to communicate ideas or raise questions. All he can do is try, he says, within the limits of the plant's procedures—limits he's careful to read and stay within, just as he is careful to read his supervisor's expectations and work within those. Eduardo is limited, too, in the literacies expected of him, although he is not as constrained as some others in the plant. As a lead in his work area, Eduardo is expected to read manufacturing process instructions and explain them verbally to the others in his group, who aren't expected to read. But he is not authorized to alter existing texts, even if they are obsolete or otherwise erroneous, to create texts which instruct others (although he appears in this instance more competent than the engineer). It's noteworthy that the texts that Eduardo does create are unofficial ones—texts that he writes on scraps of paper and pulls from his pocket nervously, texts that aren't sanctioned by the company and that have no authority. What a contrast Rod the program administrator provides in his use of texts. Rod comes bearing a huge red manual of which he is keeper, and when that manual doesn't yield the necessary document, he feels free to give Maggie and Eduardo the go-ahead just on the basis of having thought he has seen a particular document. He not only has access to documentation and the authority to create it or imagine it, but power to circumvent it.

The references to the three-ring binder and the reams of documents associated with each circuit board assembled at this factory—manufacturing process instructions which detailed every single procedure for every action in the entire plant, deviations to those instructions, deviations to the deviations of the instructions, bills of material, Corrective Action Requests, stacks and stacks of documents and instructions on how to write documents—all of this gives a sense of how important official literacy was in this factory, and the multiple functions it served. But those functions were unequally distributed, as was just illustrated, among workers in the factory. Where front-line workers were concerned, literacy served mainly to regulate and to control, to represent the authority that they didn't have. It's hugely ironic, then, in a factory where the plant manager talks about "creat[ing] a culture where people believe that they can make decisions without being put in a penalty box," that literacy practices are complicit with its old style hierarchical work organization. We might recall Eduardo trying to get into that locked room where the sample board was plugged into a system. He was desperately seeking access to that room, and he was desperately seeking access to authority, an authority that, where he was concerned, resided only in a text created by someone else. In a "high performance" workplace, Eduardo should have access, we would argue, to documentation and the authority to alter it, the authority, that is, to make decisions. We would not call him "empowered" without that access and authority. It will be interesting to see, when we turn to Teamco and its self-directed work teams, whether workers do indeed have this access and authority.

EMCO: A Training Session to Improve a Literate Process

We now look at a training session held in a crowded conference room just off the factory floor at EMCO. This particular session was unusual in that it was one of the few times we observed workers leaving the floor to receive training. It was also one of the very few times that we observed factory floor workers participating in an *officially sanctioned* group meeting at EMCO. While front-line workers met together informally, as needed, to solve the problems that occurred during the process of their work, they had no formal forum for voicing their concerns, reflecting on their work, or contributing to managers' and supervisors' attempts to regulate and improve quality and productivity. As we discussed earlier, the plant manager in fact felt that front-line workers weren't needed in the team meetings he had recently instituted for managers, supervisors, and engineers. Therefore, we were eager to take the opportunity that this training session provided to see what formal meetings were like for front-line workers. The session also gives some hints of what training was like at EMCO. In the following section we examine the interactions of the manager conducting the training with the culturally-diverse group of lead workers and material handlers pulled off the floor to receive the training.

This particular session was interesting to us in that—despite our observations of a wide range of literate activities on the factory floor—this was one of the few in which workers were trained in an expressly literate task that they were expected to complete as part of their jobs. During the session lead workers and material handlers were walked through a revised procedure for completing a Movement Log form (see Appendix C). This form was used to track the movement of products as they progressed through the manufacturing process. For example, a log had to be completed every time a batch of circuit boards was moved from the Surface Mount Operations area, where machines automatically attach components to the board, to the Second Operations area, where more manual processes take place. Leads or materials handlers in each area must complete the form, counting and listing each different part by number. Throughout the day, these forms were entered into an electronic spreadsheet. And at the beginning of each work day, the Work in Process (or WIP) report (see Appendix D) was revised from the movement log data.

The WIP report was very important to the plant's efficiency in that it was used by managers throughout the factory to schedule production, juggle priorities, and negotiate commitments to the company's customers. However, throughout the plant, the WIP had been recognized as inaccurate and, therefore, as only a very rough estimate of where products actually were in the manufacturing process. For instance, Vivian, a lead from the Test area, stated frankly, that "the WIP, it's a big laugh, but you have to have some something." Various workers and managers had different opinions about the reason for the inaccuracies—including illegible handwriting, a lack of discipline, unlogged movements, and the lack of automation. However, just about everybody agreed that the

Movement Log forms were not being completed as specified in the Movement Log procedure. Hence, this training session on the procedure.

EMCO's long-term solution to the WIP report inaccuracies was to automate the process of accounting for production movements by using a bar code system similar to those found at many grocery store check-out counters. Until that time, the company's goal was to improve the accuracy of its current manual system by instilling in workers the importance of completing logs for each movement. Therefore, at the time of the training session, the only procedural change in how workers were already working was that they should conduct the transfer of products from one area to another only at several designated locations, marked by red tape on the factory floor. The factory's managers felt that this small change might help isolate the transfer of products as a discrete tasks and, therefore, highlight for workers the necessity of completing a Movement Log form every time products are moved.

The training session we will examine had as its purpose reviewing the revised Movement Log Procedure. The meeting took place at 1:30 p.m. during the day shift. There were approximately 15 factory floor workers, both men and women, in the room. The workers sat around a large conference table. All had pens or pencils; some had clipboards.

The leader of the session was Mark H., the factory's production control manager. He was the only European-American participant and stood at the front of the room. He is in his mid thirties and has a bachelor's degree from a local university. Mark came to EMCO several years ago when another electronics manufacturer he worked for was acquired by EMCO. In a short interview after this training session, he stated that he "loves training people." The reason: "Just to see their faces lighten up with the, you know, 'Hey yeah, that's right, yeah.' Plus, I get the interface back from them. And I learn from them while I'm training, I learn things."

It's important to note that Mark H.'s authority over the workers in the room was tangential and not direct. He is clearly one of the factory's managers, but not the front-line workers' supervisor. As he said in an interview after the meeting: "I'm going to talk to the supervisors and ask each supervisor to get with them individually and make sure they feel empowered. Because, again, I'm not their boss. I can just tell them what I told them. But I'm not their boss." Mark H. explained his own responsibilities as, "to get product to the floor and get it built in time to meet schedule. Which encompasses shortage tracking, machine scheduling, all kinds of stuff."

The session began with Mark H. passing out copies of the procedure and making sure every work area of the manufacturing floor had sent at least two representatives. (See Appendix E for a copy of the procedure.) Next, he read aloud the written procedure for completing movement log forms. He explained the justification for the procedure and how to complete the form accurately. This lead to a discussion of why the current procedure was not being consistently followed and the reasons for the inaccuracies. These included moving assemblies at the end of a shift, legibility, people who shouldn't be moving assemblies, and people on the third shift moving boards. Problems raised and solved during the session included how to assert authority over people who are not authorized to move assemblies; accounting for assemblies only, not component parts; how to account for assemblies being worked on by engineers; who to ask about questions when completing the movement log forms; and making sure that everyone necessary is trained in the new procedure.

Typical of the several training sessions we have observed at EMCO, Mark H., the leader of the session, held the floor for the vast majority of the time. Throughout the session, Mark H. maintained strict control over participation in the session. He validated or invalidated workers' contributions of topics or suggestions of solutions. For example, he judged one worker's concerns about moving boards at the end of a shift as a "valid problem." On the other hand, another worker's suggestion that material planners were moving parts incorrectly was dismissed: "Different subject. Different subject. We can talk about that outside of this." In both his statements and the manner in which he conducted the training, Mark H. drove home a theme that our research team observed consistently at EMCO: Despite claims on the part of the plant manager that the company was attempting to implement team-like practices, established management hierarchies and realms of authority continued to be honored.

Since one of the goals of our research was to identify the rules and strategies that people used when they interacted with print in the workplace, in this particular session we wanted to analyze carefully speakers' talk as they discussed the Movement Log form. In particular, we hoped to reveal what the linguist Robin Lakoff (1990) describes as the more complex subtexts that underlie discourse. To better understand speakers' intentions during the training session, we used the tools of linguistic pragmatics—including deixis, speech act theory and conversational logic—to examine the beliefs, attitudes and intentions of speakers. In so doing, we want to show that the demands for collaboration and communication within changing workplaces don't merely shed light on the importance of workers' literacy and language skills, but also highlight how workers are perceived by managers within a workplace, and how such perceptions, in turn, reflect back upon the skills workers are expected to demonstrate at work. We were also specifically interested in what could be observed about the relationship between the workers' English proficiency and their ability to participate in formal team-like meeting within the workplace. We wanted to understand if Mark H. as leader of the session was making special accommodations within his speech to communicate with the non-native speakers within the room, since we noticed right away that he was speaking differently than he had previously talked in informal conversations with us or in meetings with his peers or managers.

For this particular training session, we will highlight the following pragmatic analyses:

• Anaphoric Pronouns — Pronouns are generally supposed to be "coreferential" in that they refer to some person or object already mentioned in discourse (Green, 1989). However, in business discourse, especially that used by skilled managers, there is often a great deal of ambiguity about who is being referred to, especially when using the third-person pronoun, *we*. Lakoff (1990) defines these ambiguous uses of *we* as the inclusive and the exclusive *we*. The inclusive *we* includes the hearers, meaning 'you and I.' The exclusive *we* means me and some others, but not you. Used together effectively, the inclusive and exclusive *we* can have a subliminal effect of communicating "unity, comfort and authority" simultaneously.

• Irony — One form of indirect speech acts we've observed as particularly prevalent in informal workplace discourse is irony. Using irony, the speaker assumes that the hearer has background knowledge that not only includes understanding the literal meaning of the speech act, but its ironic opposite. It places emphasis on the cooperative nature of the indirect speech act, suggesting a psychological unity of understanding between the speaker and hearer. Yet since irony can also be used as a "put down" (such as saying “nice haircut” in an ironic tone, while simultaneously raising your eyebrows), it doesn’t always reflect social unity. Irony used in workplaces, even between workers at very different stations within the organization, can communicate subtle and important meanings.

• Elaborated and Restricted Codes — Basil Bernstein says such codes “symbolize the form of the social relationship, regulate the nature of the speech encounters, and create for the speakers different orders of relevance and relation” (1972, p. 161). Bernstein defines two major types of codes: restricted and elaborated. *Restricted codes* depend on particularistic and context bound understanding, and are often tied to a local relationship or social structure. *Elaborated codes*, on the other hand, are more “universalistic,’ where meanings are made explicit and are less tied to a local social structure, but are played out against a more general backdrop of common knowledge (Bernstein, 1972). Within a business setting, the use of restricted codes suggests a commonality among discourse participants—’Hey, we’re all in this together”—whereas elaborated codes allow the speaker to take an official stance. The speaker is able to impart what he thinks his audience must know. In doing this, the speaker can also prove his or her own knowledge to others in the room.

• Conversational Implicature — H.P. Grice (1975) proposed the mechanism of *conversational implicature*, in which hearers use the discourse context to interpret the speaker’s meaning. Such interpretation depends on the participants assuming the Cooperative Principle, where all parties are confident that the other is trying to communicate in an agreed upon way. Examining those instances in discourse where conversational maxims are violated, yet people still understand each other, we are able to reveal the importance of the social and psychological framework for supporting communication. In workplace discourse, such conversational implicature can uncover knowledge that is relied upon within the confines of the work environment, but often is not acknowledged as skill.

Let’s now look at the Movement Log training session, using these four strands of analysis:

We, You, I

One of Mark H.'s more subtle but effective uses of language involves social deixis through his choice of pronouns. Like an accomplished politician (cf. Lakoff, 1990), he blurred the distinctions between the inclusive and exclusive we to both assert his authority as a member of the factory's management team, yet also to persuade workers over whom he had no direct power. At first, Mark H. started the session by establishing his own authority, making the distinction clear between we, the management whose offices are upstairs, and you, the factory floor workers who occupy the ground floor:

> Okay, we'll go ahead and get started. Chin you can go ahead and grab the door there, and we'll get started. Okay, first of all, everybody know why they're here? Is there anybody that doesn't know why they're here? Or you all want me to tell you why you're here. We're all here, basically, to re-hash or go over how to do movement logs. (??) track of one assembly from one work area center to the other work area center. Um, very important job. In fact, it's one of the most important jobs you guys do down here, besides actually building the product is keeping track of where the product is. Because everybody upstairs, all the programs people, and the different managers, and Sam, um, all use what we call the WIP report. I think everybody's seen this. It has all the different boards we build, and all the different work area centers, prep, (?), it's got all these areas here. And it tells us where all the boards are at, in the process, each day, we put this report out every morning.

Chin, whom Mark H. directed to close the door, is a lead worker in the Hardware area of the factory. Chin is a Korean immigrant in his mid forties. He has a BS in electrical engineering from Korea. Like many workers, he came to EMCO when the company he worked for was acquired by EMCO. He wasn't observed in any other meetings other than this training session.

Soon, Mark H. started varying between his use of the exclusive and inclusive "we". Clearly, the "we" who make decisions about the factory and need the information collected in the movement log forms are not the same "we" who move boards. He used the second-person "you" whenever he wanted to directly or indirectly get the workers to do something, communicating that it's their responsibility to do it. And he used "I" when he asserted his own beliefs or desires, especially regarding areas over which he has control, such as the movement logs themselves or the management of the training session. For example, when explaining that workers should write the actual time of board movements on the log forms and not just check one of three times printed on the form, Mark H. used I, you, and we within the same utterance:

> We're always moving boards, because we're so fast. So, I want you to write in that time. Actually just write it in. But I think everybody's been doing it. The ones I've seen everybody's been writing it in. Now if it happens to be ten-thirty in the morning, go ahead, circle it. You know, save you some writing. But make sure you put in the time of day there, and a.m. or p.m. Because we do have other shifts, as well. That'll help us if we have a problem later, we can track down. So you fill that in. After you've got that all filled in, on the top, then you want to put in the (?) assembly number, the QAP-9, da-da-da-da-da, or QMI-9, so on and so forth. And you want it to be the exact same part number.

Throughout the session, Mark H. deftly used social deixis and nondeixis (Lakoff, 1990) to subtlety emphasize his own authority and the workers' responsibilities. At certain times the exclusive we allowed him to claim authority through his membership with the factory's management. But when his authority was not certain, requiring his skills of persuasion, he shifted to the inclusive nondeixis we. And for those instances where he had the power to tell the workers what to do, he used the direct you and I.

Irony

From the start to the finish, Mark H. used irony during his talk to suggest a commonality between himself and the workers. Early in the meeting irony was initiated by Chin in response to a serious question by Mark H. Mark H. then played off Chin's joke to carry forward this style to establish his own position of authority in the meeting.

Mark H.: What if you're sick? Who takes over when you're sick?

Chin: Ohh. Well, you see, I'm not gonna be sick.

[Everyone laughs]

Mark H.: Oh, you're not gonna be sick? Oh. Okay. Give me the secret. Actually, I was thinking it would be Mohammed or Chin that would take over, if I know Cabrillo, that's who he would make do it.

Chin: Okay

Mark H.: Right? If I know Tom, he'd make you do that, wouldn't he?

Chin: Yeah, he would

Mark H.: He'd go Chin, and Chin wouldn't answer, and he'd go Chin-Chin

[Laughter]

By responding in this manner, Chin, a factory floor worker challenged Mark's H.'s authority to demand this information; yet he presented his challenge within the safety of humor. He signaled his humorous intent by prefacing it with the hedge, "Ohh. Well, you see." The speaker then violated Grice's maxim of Quality by asserting information he is not in the position to know. Humans are not in complete control of their own health; therefore, no one knows for certain that they will never be sick in the future. This is clearly an ironic statement; the illocutionary force is very different from the propositional content. I seriously doubt that Chin would have responded similarly to his own direct supervisor. But by presenting his challenge humorously, he also pushed Mark H. to subtly define his own position of authority and rapport with the group.

Mark H. signaled that he caught the speaker's ironic intentions by picking up on his ironic tone with a feigned sense of amazement: "Oh, you're not gonna be sick? Oh. Okay. Give me the secret." Mark H. skillfully responded to the challenge by carrying forward the humorous tone. He suggested that he was not offended by the worker's challenge. Yet, in his response he clearly established his own links with the speaker's direct supervisor, Tom Cabrillo, the clearest figure of direct authority over the worker. And he also indicated his own serious intentions with the word "actually." By stating what he believed would be the response of the worker's supervisor, Mark H. asserted that he understands the thinking of the supervisor and that he belongs to the same authority group as the supervisor. Mark H. then drove home the hierarchical nature of the organization by asking the worker to confirm that the supervisor would "make you do that," which the worker confirmed in a direct manner. However, after clearly establishing his own authority position, Mark H. used humor, subtly mocking the supervisor, and thereby establishing rapport with the workers. From the reaction of Chin and the other workers in the room, I don't believe his saying "Chin-Chin" was meant or taken pejoratively.

Mark H. used irony several other times throughout the session to further his rapport with the workers or to assert his authority in an indirect fashion. For instance, when he asked for one of the men in the crowded room to give up his chair to one of the women, he used irony ("Boy, talk about pressure, I tell you") to diminish any pressure associated with the action. Recognizing that most of the workers were already familiar with the movement log form, which they were discussing, Mark H. joked ironically, "There's a sample on the third page there, of the movement log, which you probably all got memorized and dream about at night, I'm sure." As in the beginning sequence, Mark H. also used irony to subtly assert his authority over workers. For example, one of the workers stated that although he suggested that you could file the Movement Logs on the data entry clerk's desk, rather than an official basket, he didn't actually do this himself. Mark H. responded, "Okay, well you just said that to cause trouble. Okay. Good work." Or when another worker suggested that she doesn't need to know a certain procedure in her area, he replied, "You're right. But when we transfer you—oh, they didn't tell you yet?"

In particular, Mark H. used irony to poke fun at other workers not in the meeting, and in doing so, establish his own camaraderie with the workers present. Usually, the people who were the brunt of Mark H.'s jokes were either supervisors or engineers who are above the workers in the factory's hierarchy, but are either at or below Mark H.'s level. For instance, when advising workers not to rush to move products from one area to the next at the end of a shift, he remarked about their supervisor, "So- I mean, I know Cabrillo's already warming up his car by then." He referred to one of the engineers as "Fast Freddie" and suggested, "He's good at moving boards," something he should not be doing. On the other hand, he lampooned another engineer who does not move boards:

Mark H.: Does Tom R- ever move boards? Probably not.

...

Mark H.: 'You move it!' Tom tells you guys what to do. Right?

Mark H. wove irony throughout the session in order to punctuate his remarks. He told the workers to leave assemblies completed at the end of their shift for the next shift to move, because "they'll have time to move them correctly, 'cause they're just getting on, they're still yawning." And he emphasized that the workers themselves might be distracted at the end of their shifts and prone to errors: "We all clean up, ( ), trying to think what we need for dinner that night, you know." He even concluded the session, by stating as people were walking out the door, "I know we all had fun."

Restricted and Elaborated Codes

One of the most glaring differences in Mark H.'s talk from casual conversation is how he switched between restricted and elaborated codes. He built rapport with the workers by using language dependent on their knowledge of the factory's procedures. At other times, as a function of this being a training session, he reiterated and hyper-elaborated the same point several times within a single turn. For example, in explaining that workers should not allow engineers or customers to move boards on their own, Mark H. hammered home his point, seemingly violating Grice's maxim of Quantity, by offering much more information than necessary.

Here he speaks with Rudy, one of the most vocal of the front-line workers in the room. Rudy is a lead worker from the Test area of the factory. He is a Filipino-American, who appears to be in his early thirties. He has a high school diploma from the Philippines. Rudy had been observed once prior to this training session in a product team meeting, where he did not speak. To Rudy, Mark H. says,

> Basically, these guys they get paid to do other things. They don't get paid to move boards. You guys get paid to move boards. You see them moving boards; stop em. 'You guys need to move a board? Great. Where's it going to? I'll fill out the Movement Log and I'll take care of it for you. Because I'm the gatekeeper. I'm the guy that, I'm responsible for this inventory in my area. Not you.' They're not responsible. I mean Roger takes a board from Test. Ah, who do we go to when we're looking for that board? We don't go to Roger, we go to Rudy. 'Where's that board?'

Throughout the training session, Mark H. elaborated his explanations with examples that draw upon familiar social interactional frames to scaffold his points about the necessity to accurately complete a movement log form each time a product is moved. When explaining the significance of the worker initialing the form, he stated:

> And then you will initial it, under issuing, where it says signature, you're gonna initial it. So basically, your initial is saying, yes, this is the correct issuing department, this is the correct receiving department, correct date, correct time, it is the correct part number and the correct quantity, and my initial says it's so. Just like writing a check to the bank. You know? I agree that I'm takin' out two hundred and fifty dollars in cash. And then you sign your check. This is the same thing. Actually, these boards are money. When you think about it. This is how we make our money, by building these.

However, Mark H. also freely shifted from such elaborated codes to more restricted styles, drawing upon the workers' inside knowledge of the factory floor. He used technical terms, product names and the names of specific workers as general examples of which types of workers need to move boards for what type of purposes. For example, below he answers a worker's question on how to respond when an engineer or technician needs to take a board from the production line:

> Mark H.: Well now, if they gotta take it. If they're taking it from lets say Test and they're going to Final Ops. Great. We'll make up a movement log from Test to Final Ops. Now let's say Roger needs to take a board because he is going to do a fixture. Right. Or Ronnie needs a board because he is going to have an ICT fixture re-setup. He needs a board for that.
>
> Rudy: He needs the board for research or customer information or something.
>
> Mark H.: Right. They're going to take it out, but they're not going to take it to one of our normal work area centers. That's why I created this Engineering QA WIP location.

Here, Mark H. seemingly violated Grice's Quantity maxim; he assumed that workers have the background knowledge to use implicature and interpret his examples as indicative of any legitimate reason that an engineer or technician might have for moving a board. Demonstrating the success of Mark H.'s strategy, Rudy elaborated Mark H's point, showing he had made the necessary inferential leap.

At times, Mark H. combined elaborated and restricted codes through dramatized examples. For instance, here he described why both the issuing and receiving materials handlers must be present when products are moved and the movement log is completed:

> Okay, now, Jan went to the gate, and then she called over Chin. And, uh, then he'll go through this new (promo) stuff. Now, it says, if any portion of the movement log is incorrect, the issuing department material handler must adjust movement log and initial the correction. In other words, you said there were two hundred on there? But Chin counted it, and said, 'No, there's only one ninety-nine.' You're gonna go, 'No, there's two hundred. I counted them.' You know. But Chin's goin', 'no, one ninety-nine.' So you've got to verify the re-count to make sure that there really is only one ninety-nine. Or, there's two hundred, he's still there, and you can go, 'Hey, you don't know what you're talkin' about. Come here, you count it again.' Okay? But you guys both have to agree on the counts. Who ever's givin' it to you, and who ever's gettin' it, you both gotta agree on the counts. So you gotta both be there when it's being verified. You don't just fill it out, drop it off, and walk away, and get back with ya' later. No. You gotta do it right then and there. Okay?

Here Mark H. drew on the workers' restricted knowledge of where and when a movement between Chin and Jan would take place. In the same turn, he elaborated and dramatized how such a movement should be properly conducted. Throughout the session, Mark H. used elaborated and restricted codes to both emphasize his authority in dictating how the procedure should be carried out, and yet develop enough rapport to get the workers to listen to what he had to say.

Implicature and Limited English Proficiency Workers

During this particular training session, we were struck by our inability to understand the comments of several of the participants. Yet, it appeared as if both Mark H. and the other workers had no problems understanding each other. In transcribing this event, we found ourselves still having to listen several times to Rudy's utterances, often at different speeds, and yet, we were still unable to make out some of his words. On the other hand, Mark H. was able to clearly understand and easily carry on a discourse with Rudy and the other workers.

In the following example, Mark H. and Rudy drew upon their shared understanding of both the manufacturing process and the pressures that drive production within the factory to support speech that was incomprehensible to us at the time it was uttered:

Rudy: I think the problem ( ) is that when the board is very hot, you give a lot ( ), and then like, you go home at six o'clock. And then, ( ) around four fifty-five. And there's still a lot of assembly ( ) to verify.

Mark H.: Uh-huh

Rudy: That's where we have our biggest problem. ( )

Mark H.: So we wait until the,' oh, oh my God, it's near the end'==

Rudy: ==That's right

Mark H.: Get it all together, and let's move it all at once?

Rudy: Yep

Mark H.: Okay, we'll- we'll discuss that a little bit later. That's a good point, though. Um, I'll write that down, and we'll come back to how we can go around- at the end of shift, you've got a lot of problems.

Rudy: Yes

Mark H.: Okay. So, we'll come back to discuss that, because that's a valid problem, 'cause I've seen that.

Rudy: It's not just only the people that do their paper work and then==

Mark H.: ==They do their paper work, they give you the boards, okay, I'm goin' home. And they take off. And you're stuck there with all these boards, and you want to go home too, and then you get in trouble for working over-time.

Rudy: Mmm

Mark H.: But you're not supposed to work over-time, right?

Rudy: Yeah, that's true, but==

Mark H.: ==Okay, we'll get into that. I'll write it- we'll- we'll get into that. Okay,

Rudy and Mark H. used Grice's Cooperative Principle to do the necessary implicature to understand each other's utterances. This is different from using a restricted code, where the speakers' language assumed a knowledge of the factory's procedures; here, Rudy's limited English proficiency resulted in his violating the maxim of Quantity by not providing enough information for even us, informed listeners, to explicitly understand his point. Yet, Mark H. not only understood Rudy's illocutionary point, he responded with two indirect speech acts: "So we wait until the,' oh, oh my God, it's near the end'=" and "Get it all together, and let's move it all at once?" To identify the type of thinking that is causing the problems at the end of the shift, Mark H. used examples, in the dramatic present tense, of what workers might actually think to themselves. In using such indirect speech acts, Mark H. demonstrated that he was confident that Rudy would understand him. Rudy affirmed that he understood the conversational requirement of this type of interaction by responding interactively with Mark H., "That's right," "Yep."

Next, Mark H. attempted to regain control of the session by validating Rudy's points, then postponing its discussion till later in the meeting. But Rudy would not drop the subject until Mark H. understood the full nature of the problem: "It's not just only the people that do their paper work and then=." So Mark H. quickly elaborated his own knowledge of the pressures involved with moving boards at the end of a shift as a way of getting Rudy to cooperate with his attempt to postpone discussion of this particular issue. When they do return to the discussion much later in the session, Rudy was able to fully describe his real concern: "I think that moving the boards out is not the problem. To receive the boards is the problem."

Power, Authority and Talk

Unlike more informal discourse, talk in business dialogues is often about power: who has it, how much of it they have, and who must recognize or conform to it. But the possession of power is often ambiguous—especially in workplaces attempting to stretch formal reporting structures. As we've seen in the training session just analyzed, an effective business manager is, in many ways, like an accomplished politician. He or she must persuade certain constituencies, while having the power to compel others. Often, managers have authority over some area or function of the business, yet no direct control over the people who work within that area. Therefore, they must harness all of their discourse skills to get workers to perform actions to their liking. Through talk, Mark H. was able to make the most of his own limited authority. He had no direct power over the workers he was training, since he was neither their supervisor or manager. At the same time, the workers also asserted their own limited authority through the use of irony.

On at least two occasions, Mark H. emphasized that while taking responsibility for circuit board movements in their area, workers should respect the authority of supervisors or managers. After directing the workers not to move boards during the last fifteen minutes of their shifts, he cautioned, "If your supervisor tells you to do it, they're the boss, do what they say. That's right. But do it right. Take your time to do it right." He also advised the workers that despite the written policy they had just reviewed, they should let Sam, the plant manager, do whatever he wants: "Now, if Sam wants a board, Sam can have a board." But, they should ask Sam to sign a movement log at his convenience: "Let Sam walk off with the board. Okay. But fill out that paperwork and get him to sign it later."

The training session just analyzed suggests that a worker's ability to participate and advance her lot in such complex discourse environments depends on a capability to extract and interpret subtle meanings, such as speakers' intentions and beliefs, found within language interactions. Even when discussing what on the surface appears to be a quite basic literacy task, completing the Movement Log form, workers must be able to interpret and produce what Ricouer (1981) refers to as "the linguistics of discourse" in which "event and meaning are articulated" (p. 133). And yet, such highly-tuned discourse abilities are rarely discussed in association with the greater literacy and language skills required of workers or accounted for in calls to transform the American workplace. Instead, curricula designed specifically for non-managerial workers often focuses on discrete, 'neutral' skills or information processing.

Our analysis here does not suggest that workers lack highly developed discourse abilities. In fact, we believe that workers' discourse skills are, for the most part, still unexamined. But until we fully investigate what workers are capable of doing, we cannot effectively address the educational requirements of changing workplaces.

Teamco: A Training Class

Our narratives of work and training events at EMCO have suggested the importance of literacy in circuit board assembly, even at a factory which we deem "traditionally organized." Further, we have seen that at EMCO, work is actually arranged so as to require as few literate responsibilities as possible of its front-line workers. And we have argued that such an arrangement can spell trouble. We have also noted that few formal opportunities exist for workers at EMCO to make their views on the process and organization of work known or to participate in collective problem solving—despite the fact that workers wanted such a forum and that they engaged in collaborative problem solving during the natural course of their workday activities. Finally, we observed at EMCO that there were few opportunities for training, and that in the training sessions that we did observe, traditional factory hierarchies were in place in terms of participant structures and roles, rights, and responsibilities.

Now, in contrast, we are ready to visit a company in which every front-line worker is required to participate in a significant amount of training and to be a member of a self-directed work team. Teamco represents, we will shortly see, a dramatic turnaround from our first factory in terms of its policies regarding training, work organization, and the responsibilities and roles of front-line workers. One might say that Teamco has attempted to create a new work culture, and in so doing has wanted to foster new working identities among its employees. In such an environment one would certainly expect the development of new and different literacy demands, new literate practices that keep apace with the development of new work practices. We will thus want to ask, as we proceed with our narratives of training sessions and meetings at this factory, how do the literate practices and the work practices at Teamco compare with those at EMCO? What sorts of forums or spaces are made available at Teamco for workers to take part in decision-making and to display their newly developed or newly acknowledged literate and problem-solving capabilities? Do working relationships change with new work practices and new literate practices, and if so, how?

Teamco: A Training Class on "Accepting Change"

Perhaps the best place to go for a sense of the "high performance" culture change initiated at Teamco is the training room, where workers go to be introduced to the notion of self-directed work teams (SDWTs) and to begin acquiring the skills and attitudes they would need to function as teams. The curriculum of an educational program presumably embodies the activities and attitudes valued by the dominant culture, and thus offers a chance to understand key assumptions about learners, knowledge, and identity. Teamco's SDWT training program ought, then, to reveal the new roles workers were expected to construct, the new identities or ways of thinking, acting, talking, and valuing. We will start with a brief overview of the curriculum and its organization, to be followed by a detailed description and analysis of one classroom session.

The training classes that we observed at Teamco took place in a well-lit, high-ceilinged room that was cool, clean, and well-appointed with black metal, cushioned chairs and several rows of gray Formica tables configured like the letter "E." Two of the walls were floor-to-ceiling plate glass windows covered by light gray blinds. In the front of the room were a television set with a VCR mounted on a cart, a dry-erase board, an easel, an overhead projector, and a ten- by-twelve-foot high-quality projection screen. Along the fourth wall, placed well above eye-level, were a series of posters articulating Teamco's SDWT philosophy, including the definition and goals of self-directed work teams. The feeling in the room was modern, high-tech, and to those accustomed to the aging physical plants and scant resources of public schools, well-off.

During classes there were approximately fifteen to twenty-five front-line employees present. In the classes that we observed, there was an even mix of women and men; nearly all were Asian American, about eighty percent Vietnamese, with a sprinkling of other ethnicities, including Chinese, Filipino, Mexican, and Puerto Rican. All of these workers spoke languages other than English as their first language, and many were bilingual or trilingual, speaking, for example, Vietnamese, Mandarin, and English, or Tagalog and English, or Spanish and English. Some workers were quite proficient with English, as was Juan, who will be introduced below, but others had grave difficulties understanding lectures and reading materials and participating in class, which was officially carried out in its entirety in English. Interestingly, in the recent past Teamco had conducted at least some parts of its quality enhancement programs in four different languages—posters and other literature were written in English, Spanish, Chinese, and Vietnamese, we were told. But the SDWT effort would be English-only. "We consciously made the decision that we would not ESL this program," explained one member of the training department. The rationale was that first of all, given the structure provided by a team, people who knew the language could help those who didn't, and thereby excellent workers who were poor communicators in English could still participate and contribute. As far as the classes went, according to this trainer, the company wasn't overly concerned that workers absorb every little detail of the curriculum: "Understanding the material is not really our goal. The goal is for the team to understand why they're a team and the fact that they have certain specific goals. They're given the power to solve their own problems and to improve their own productivity." So it seems that the major purpose of the class was to inculcate new attitudes and a new sensibility toward work, a process that was assumed not to depend on perfect English. Later, as workers actually took part in team meetings, they would acquire the needed knowledge and skills through immersion in real work activities and through collaborating with fellow team members.

At the outset of training each worker was supplied an in-house textbook, a smart-looking three-ring binder with tabbed sections for some fifteen different topics, including "Effective Team Meetings," "Basic Finance," "Problem-Solving Skills," "Understanding Differences," "Effective Listening," "Handling Problems," and "Accepting Change." Each chapter contained a list of learning objectives, a series of exercises (some to be done individually, some in groups), and a section for employees to record what they had learned each day. According to Teamco's training department, most of the curriculum is standard fare, available from vendors who specialize in corporate quality enhancement programs—"everything is out there," as one trainer put it. These materials were simply collected and customized and repackaged in the context of this company's interest in teams. (Indeed, we've come across some of the same exercises, such as how to construct a "fishbone" diagram of the potential causes of a manufacturing problem, in the training literature of other companies.)

To get a sense of the curriculum, the ideas it embodies about teams, and the new identities suggested for workers through the enactment of that curriculum, and the nature and role of literacy in all of this, let us look in detail at a portion of a transcript from a class meeting. This session was Lesson 12, about two-thirds into the course, and was called "Accepting Change." As the transcripts and summaries of classroom talk are presented, it would be helpful to monitor what is being taught explicitly in the class and how. What ideas are workers acquiring about work, in this case, about accepting change at work, and how will these ideas impact their notions of and expectations about teams and their roles as team members? What pedagogy is in place here—how does the class operate, and what does it require of participants? What literate abilities are required of participants? And what implications does the teaching approach have for workers' burgeoning identities as members of self-directed work teams?

Gladis, the instructor, had been at Teamco for only a year, but was playing a very active role in SDWT training. At this point she had taken 300 workers through all 20 lessons in the curriculum, and she taught as many as 11 classes a week. In the class discussed here Gladis is subbing for an absent teacher. Present in the class are Thanh, Juan, Aurelia, Tuyet, Phan, Khim, Nham, Niko, Lan, Kim Sa, Phong, Tam, Vuong, Hoang, and two researchers. Of these students, only a few play very minor parts in the class or figure at all in the transcript provided below. As we will see, there was very little "class participation." But let us briefly introduce a few of these worker/students to give a sense of the range of their backgrounds and their attitudes towards teams.

- Juan told us he is Puerto Rican (although the Spanish-speaking researcher among us suspected that he is Salvadorian given his accent and vocabulary, and for citizenship reasons claimed the other origin.) Young, twenty-something, and very upbeat about his work, his schooling, and teams, Juan is a permanent employee. He has worked almost everywhere on the shop floor—in Mechanical Assembly (where large parts are affixed to circuit boards by hand or other products are assembled), in solder pot (where a worker holds a board over a fountain of molten solder and one one component at a time), in wave (where parts are soldered to boards "mechanically" and en masse as they pass through a large machine on a conveyor belt); in Touch-Up (where repairs and final touches are added by hand). Juan thinks the electronics industry affords him a lot of opportunity. He is proud of his on-the-job training, and has shown us his training certificates several times, including his SDWT badge and stickers. A swing-shift worker, Juan takes classes at a local community college during the day, where he is working toward an AS degree in electronics; he hopes this will lead eventually to an engineering degree or a managerial position at Teamco. He particularly looked up to Teamco's one Latino engineer, whom he viewed as a friend and mentor. Juan's English is quite good, and during SDWT classes, he was often called on by the teacher to read; occasionally he would translate or speak for other Spanish background employees, such as Aurelia, whom we will meet below. On the last day of class, when the instructor asked for comments about teams, Juan said that teams are very important, and everyone ought to be on one. Later he served for a month as the leader of the team from the wave area.

- Hoang, a Vietnamese-American also in his early twenties, worked on the Touch-Up line. He has been in the US about one year and was recently made a permanent employee at Teamco. Hoang has much trouble with English, although he told us he could understand more than he could express. He too was taking classes at a community college, ESL, but wasn't fond of his teacher who had told him not to participate. Also, he felt the ESL lessons there were too simple—just rote grammar and very little actual conversation. Hoang loved to sit and talk with us during break time because he said it was one of the few occasions he had to speak English. And sometimes even during work, as we walked past his line, Hoang would swivel his chair around to converse with us, although workers down the line from him yelled in Vietnamese to get back to work, comments he let roll off his back. In SDWT classes Hoang was apt to joke and laugh at other people who were having trouble with English—a way of venting his own frustration, we would wager. However, he seemed to apply himself in class—reading along with the teacher, repeating words under his breath, writing down words that he didn't know, looking to the researchers for help. Hoang was not enamored of SDWT classes or the concept of teams. He summed up his attitude toward classes by noting that "I'm not a parrot." Hoang quit his job at Teamco after being employed there about 14 months; his co-workers aren't sure where he went.

- Aurelia was a friend of Hoang's; they sat next to each other in the Touch-up line and often talked and joked. Originally from Mexico, Aurelia has been in the US twelve years, is in her late 20's, married with two children. She is the only non-Vietnamese worker in the line. Although Aurelia went through a six-month course in electronics training, during which she learned to read electronic color codes and to hand solder, her work at Teamco has been quite circumscribed. She started off in Touch Up snapping components into sockets, and currently she removes masking from boards and performs similar mechanical tasks. According to another Latina in the factory, this lack of mobility bothers Aurelia and is one sign among many that the company discriminates against non-Asian workers. But to us, Aurelia has said that she likes her current job, which she prefers to the more tedious hand-soldering: "Sometimes easy, sometimes hard. But I like it, mechanical." Although her English is presently somewhat limited, we noticed that Aurelia has made progress in the year that we've known her. Within the SDWT class she worked hard to improve her English, focusing on the workbook and following along as her teacher read, mouthing words she didn't know, seeking help from the researchers. She reported to us that she liked the classes because they gave her the chance to practice English, but that she didn't learn much else: "We don't learn nothing. Uh, I forgot it. No, I forgot everything. But it's good because we learn more English."

Now to the class. Gladis the instructor began by making sure that everyone had signed in; otherwise, she warned, they would have to repeat the session. Then, as was customary, the class reviewed the last week's lesson, which was on "handling problems." We pick up with Gladis asking whether anyone remembers the steps to handling problems. She then goes on to review the "Basic Principles" of self-directed work teams (printed on one of the company posters high on the wall), and from there she introduces the topic of the day, "accepting change."

Gladis: Anybody remember the steps? [.02] What are the steps to handling problems? [.03] You can go back [.01] to that lesson if you want to [almost .01] and take a look at the steps. [.02] Somebody want to read em? [.04] Taking a volunteer. [.03] Any volunteers?

Male: [to the fellow sitting next to him] You.

Several people: [laugh]

Gladis: You'd love to volunteer each other, huh?

Group: [laugh]

Gladis: Kim?

Kim: Yes [softly].

Gladis: Okay, thank you.

Kim: [reading from binder] Uhm, ( ) number one tell him of the problem as soon as possible. Number two. Have facts when you are telling him about the problem. Number three. Give him a chance to express his opinion. Number four. Review the facts to ( ). Number five: Discuss useful solution. Number six: Decide what each of you will do to correct the problem.

Gladis: Okay, thank you Kim. Okay, six steps to handling problems. [.03] Did anyone have an opportunity to use any of these steps to handling problems in this last week? [.02] Anybody? Nobody had any problems this week?

Male: No.

Gladis: No.

Male: No.

Gladis: Okay. Well I guess that's, good. What about basic principles? Anybody have an opportunity to practice their basic principles? [.03] No. [.03] [Looking up at the poster of "Basic Principles" on the wall] Nobody helped "maintain someone's self confidence or self esteem"? [.02] "Maintain good relationships with your co-workers"? Bet you all did that. Right? ... All right.

The topic for today is going to be learning to accept change. Change is a fact of life. All right. For a company like Teamco changes are constantly occurring. All right. It's just a way the company wants to make an improvement, there's got to be constant change. A lot of times we don't like some of those changes. Uhm, we just have to learn how to deal with them. And this is why we're teaching you this class, so that you can learn those skills in learning to accept change in a positive way rather than a negative way.

At this point Gladis reads from her teacher's guide the distinction between changes "we are in control of" and "changes that are imposed on us." The latter is the type the class will be learning about—when you get a new boss, she explains, or a work process has changed or you are asked to switch shifts or you have a reduction in work hours. She introduces the notion of change by reminding old-timers, those who have been at Teamco for more than two years, that many changes have already taken place. She asks for examples of changes, but people don't respond, in part because only three employees fall into the old-timer category. After many questions and proddings, she creates a list of changes: the introduction of self-directed work teams; the color, length, and laundry requirements of the smocks that workers are required to wear (this is a change that Gladis brought up); new buildings; a new teacher (a reference to Gladis); new supervisors; new bosses. One worker tries to explain a change in the production line, but Gladis has trouble understanding her pronunciation, and twelve conversational turns are given to clarification, with Juan's assistance.

Next the class reads a memo written in 1829 by the Governor of New York State to then US President Jackson complaining about the replacement of canal boats with trains. (The text of this memo is provided in Figure 13.) After the class reads the memo silently, Gladis asks questions, much in the mode of a reading comprehension test. "What changes did the Governor object to?" she wants to know, and eventually elicits responses that the Governor thought that trains traveled too fast and that women and children would be frightened by their speed. Someone also points out that the Governor objected to the expected loss of jobs among boat builders. Gladis then goes on to comment on how most people respond negatively to change, as did the Governor:

> All right, we do know that trains are are our system of transportation so it did happen even if he didn't want the change. He wrote to the President and he had to accept the change, but he was very negative about it. Okay. And that's basically how the majority of us react to a change that scares us. All right, we're comfortable in a situation that you're in. All right. He was comfortable with knowing canal boats were out there transporting people or material or whatever, and any kind of change was scary. People would lose this job and so forth. So we react a lot of times in the same way. All right. So now that we saw some of the changes that occurred at Teamco, what kind of responses have you or others shown towards these changes? How have you responded to some of these changes? Have we been positive about all of them? When you were told that you were going to start going to classes, was everyone real excited? [.02] No.

The next part of the lesson is a video of a worker who has been told that her starting time has changed, that she will need to come to work at 2:30 rather than 3 o'clock, in order to promote teamwork between shifts. The worker is not in favor of the change, especially since it means she will have to leave a training class early. The first part of the video shows her complaining to a fellow worker, and in the next part of the film, the worker talks to her manager, who explains the necessity of the change and suggests that the worker's training class can be rescheduled. The worker accepts the manager's explanation and agrees to have her class rescheduled. The latter vignette is offered as an example of accepting change appropriately.

Figure 13: Memo to US President Jackson from the Governor of New York, Included in Teamco's "Accepting Change" Curriculum

TO: President Jackson
FROM: Martin VanBuren, Governor
DATE: January 31, 1829

The water canal of America are the most important kinds of transportation we know today. If we do not have canal boats, and have railroad trains, this would not be a good idea because:

1. Boat builders will lose jobs. The towline, whip and harness makers for the horses will lose jobs.

2. Canal boats are very important for the protection of our country. If America goes to war with England, the canals can move the supplies very quickly.

As you may well know, railroad trains move at a great speed of 15 miles per hour. Engines are dangerous for the passengers, and they set fire to the farmlands and they scare the women, children and farm animals. God does not want people to travel at so fast a speed as 15 miles per hour.

Sincerely,

Martin VanBuren

Following the film, Gladis tells the class that it's time for "our role play" on how to respond to change, which she represents as an occasion "to practice using the steps" provided in the textbook. The class is directed to divide into groups by counting off sets of three. In each group one person will pretend to be a worker who learns that additional responsibilities will be added to his job, another person acts as the worker's supervisor, and a third evaluates the worker's process. There is much confusion as the class tries to figure out what is expected in this exercise, and Gladis walks about the room giving advice and explaining the exercise again and again.

One group consists of Aurelia, a Spanish speaker; Hoang, who is Vietnamese (both of whom are described above); and an English and French-speaking researcher. Aurelia didn't seem to understand the exercise, the researcher reported, but valiantly attempted to participate by focusing on the instructions in the textbook. Hoang did understand what he was supposed to do, but explained that he didn't always have the words to express what it is that he understands. He kept laughing, blushing, and shaking his head throughout, looking from Aurelia to the researcher. Finally, Juan joined the group and joked to Hoang, "Hey.. tell her [Aurelia] if she doesn't do a good job she's gonna clean toilets." Everyone laughs, and Juan continues, "Every time I'm supervisor with this guy here I always send him to clean toilets." Hoang then turns to Aurelia and continues the joke, "OK you want your new job... new job clean toilets." Ironically, in the role play, Aurelia had been assigned the supervisor's role, and Hoang the worker's, but Hoang handily reverses them.

Gladis brings the class back together, asks if they have followed the steps and practiced the basic principles during the role play, and then reminds everyone that "changes are always being made because ... they want to improve something. Okay. Always for improvement. So, it's up to you to understand why they're happening." The final part of the lesson consists of Gladis' directive to apply what they've learned about accepting change to their teams and to write what they've learned in their binders:

Gladis: The following is a check, the team check list. This is not for you ah to fill-out right now but it's like a reference that you can go back to once you're in your teams. And you want to find out, especially if there is a change, and you want it so (I) can check yourselves to see how well you accepted it. Go back and ask yourselves these four questions. Did the team find out what the changes are? Did the team find out why the changes are being made? Did the team find out what they each have to do? And did the team find out ways to support the change? You can answer yes to all those questions, then you have effectively accepted the change. If not then you know where there's room for improvement. All right. And then last of all the bottom of page five is the summary. You may need, you may need to be very patient during some times of change. Some members of the team will resist change and they need your help to see how change can benefit them by having a positive attitude of how I help, how can I help this work better you will contribute to the team's success. You may find that the change process may be challenging and it could be fun. And a lot of times changes are. So, it's how we deal with them that means the difference. If we deal with it with a very negative a lot of times you're not going to get uhm a good result from it either. All right. So if you want good results, (always) understand it and deal with it as best you can. Okay. Any questions. Now we all know how to accept change? Okay. We're going to deal with it positive, right. Yeah. Okay. All right. If there's no question, let's go to the front of our books under the introduction section and write down one thing that you learned today in our Pearls of Wisdom [a page in the binder ruled off for the fifteen lessons with spaces to record a sentence or two of what was learned in each.] Okay. All the way to the front, look at the little tab that says Introduction.

Female: All right.

[pages turning, .14]

G: One thing that you learned in class today. [students writing for 2.28]

Aurelia writes, looking back and forth from the text to the section she is supposed to fill in, "I learn about canal boats are very important for protecting our country." Three other workers read their more conventional "pearls." Gladis dismisses the class.

Teamco: Observations on the SDWT Curriculum and Class

In a part of the transcript not quoted above, Gladis the instructor reminded her class of how grateful they should be to be able to take part in SDWT training; she said that other companies wouldn't invest financially in such a program, and still others wouldn't believe it could work. In many senses she is right. Thirty-eight hours of training that draws workers off the shop floor during peak production periods to come together to learn; an elaborate system of certification and awards to continue that training; the entitlement, indeed the directive to go forth and solve problems as a team; and the chance to present your solutions directly to management—all of these practices are laudatory, and we salute their spirit and intent. We are aware that many a company is willing to invest in training for management (EMCO comes to mind), but continues to eschew responsibility for front-line workers, particularly when those workers are recent immigrants and when they have been relegated historically within the industry and the company to "non-thinking" jobs. It is important, then, to honor what was intended at Teamco and to award it considerable due. We are disturbed, however, by what actually emerged in practice, and the classes are a prime example.

One of the things about the experiment at Teamco that we most admired was its implied belief in people. The manager who was the mover and shaker behind the team concept was ready to defend the hourly workforce at every turn, expressing great faith in their abilities. He was especially proud of certain portions of the curriculum, such as the part on finance, and his decision to expose front-line workers to the mysteries of the income statement and the balance sheet. "This is for everyone," he said proudly, "the eight-dollar-an-hour, I-don't-speak-English worker. They said I was crazy." A corporate trainer with whom we spoke likewise described the workers as Teamco's greatest asset, diligent and unfailingly loyal. And indeed, the whole idea of a curriculum to be presented to workers during the work day in an industry governed by sudden and exacting customer demands bespeaks of someone's belief in workers and in the importance assigned to their growth and development.

Unhappily, when we examine the curriculum and the pedagogy of the class described above, we see another view of workers, and we believe a most unproductive one. This view is perhaps best summed up by the regular instructor of the class, who commented to us that "sometimes I feel like I am teaching children." Indeed, the organization of the class, the participant structures in operation, the building-block approach of the curriculum—all of these things are strongly reminiscent of old-style, traditionally-run classrooms for children and adolescents; they certainly don't bring to mind the education of adults who are being empowered to solve their own problems.

Let us be more specific. Even a cursory look at the complete transcript of the class shows, as do the excerpts provided above, that the vast majority of talking is done by the instructor; a closer look informed by an analysis of discourse shows that upwards of ninety percent of the conversational turns in the session (the group work being the only exception) are controlled by the instructor. This lecture format, especially considering the fact that many participants had difficulty with English, meant that most people never participated at all. Training room talk can best be characterized as consisting of these mini-lectures interspersed with the most pervasive, traditional participant structure of schooling, the IRE format (cf. Mehan, 1979). In this format a teacher initiates a question, a student responds with an answer, and the teacher provides some kind of evaluation of the response. IRE participant structures often involve "known answer" questions, in which the instructor knows at the outset the correct answer to the question, and is checking through her question to see whether the student can provide it. For example, in the section of the transcript in which Gladis asks the class what kind of changes the Governor of New York objected to in his letter to the US President, this exchange, typical of IRE discourse, occurs:

Gladis: What were some of the changes? (INITIATION)

Female: They didn't like the railroad train. (RESPONSE)

Male: The train, the train. (RESPONSE)

Gladis: They didn't want the railroad train. All right. (EVALUATION)

Gladis typically signaled a positive evaluation of a response with the phrase "all right," varying the degree of affirmation through emphasis and tone.

The effect of an IRE participant structure and known-answer questions coupled with classroom activities such as calling upon people to read aloud, a classroom arrangement that has the teacher standing at the front of the room and the students seated in rows, and an approach toward concepts that divides everything into what often seem like nonsensical steps—all this has the effect, we would argue, of infantalizing the participants. Indeed, we observed some of the younger workers acting like resistant adolescents in a high school classroom—passing notes, giggling with each other, generally goofing off instead of taking the assigned tasks seriously. Add the further complication that many participants had trouble comprehending the language of instruction, English, and therefore relied on strong non-verbal cues and most likely their own memories of childhood schooling to make sense of the situation, and you have a classroom that epitomizes what Freire has called the "banking" concept of education: Students are empty receptacles with no knowledge or expertise; teachers are depositors, with an unlimited supply of knowledge and expertise, which they provide to students in a one-way exchange.

The literacy practices that were part of the training drive this point home. When we first sat in on the training classes, we were amazed at the considerable literacy and language requirements of the course. There was the in-house textbook, which made no concessions to non-native speakers, and the language of instruction, which did itself not appear to be modified or simplified. Rather, participants were expected to read, write, and speak English at fairly sophisticated levels. Now, we have already pointed out that these expectations were unrealistic for a substantial proportion of the participants, simply because their English was still developing; Aurelia is a good example of this group. But let us assume that everyone could read, write, and speak English well enough to participate fully in the curriculum. What kinds of literacy practices were valued, and what do they suggest about the sensibilities that workers were supposed to develop as team members? Workers were supposed to absorb the content of the textbook through their reading, and through their writing they were supposed to reproduce it. Not once in all the classes that we observed were participants ever invited to respond critically to reading material—by contrasting their own experiences to examples provided, by revealing what seemed particularly apropos and what wrong-headed, by offering additional topics to be discussed or covered. The writing activities were even more circumscribed and limiting, consisting as they did of fill-in-the-blank type questions, check lists, or the "pearls of wisdom" summary of what had been learned. It's important to remember that such activities, such approaches toward literacy and learning, send powerful implicit messages about what is expected and what is appropriate of workers. We would argue that the message sent here is "don't question," "listen carefully," and "follow directions."

It's hard to imagine a classroom structure or orientation more unlikely to suggest to participants that they are being empowered to solve the company's problems, to be active thinkers and doers. The manager in charge of the team concept told us the company used to "hire from the neck down," but with teams, "employees will have to think; those who don't want to think will go." The corporate trainer echoed him: Workers shouldn't "expect always to be told what to do. You need to think for yourself what's needed and take the initiative to do it." The SDWT training program, its curriculum, its pedagogy, and its literacy practices would seem to encourage just the opposite.

In the case of the "Accepting Change" class, the content of the curriculum itself promoted passivity rather than activity and initiative. Participants are directed, whenever change in their work lives occurs, to accept it appropriately by following a series of steps:

Find out what the changes are, why they are being made, what you have to do differently, and how to support the changes. Staggeringly, there is no urging to assess the changes or provide feedback about them. Perhaps this is a predictable stance for companies like Teamco which expect, even welcome, whatever changes are necessary to stay on top, and thus feel compelled to head off any resistance on the part of their workforce. Ironically, though, through an SDWT session that directs workers to simply accept change, and through a hierarchy perceived as rigid despite the existence of teams, the company shortchanges and short-circuits itself.

One more comment on the content of the "Accepting Change" class. There were several missed opportunities for meaningful discussion, moments when at least some of the class could have been drawn into a genuine conversation in which their opinions and ideas were valued. One of these opportunities came when Gladis asked what changes the participants had noticed during their employment at Teamco. Having spent some months in this factory, we can report that workers are positively besieged by change on a daily basis and feel the pressure of change enormously. But these experiences were not verbalized, as Gladis, perhaps under pressure to cover the curriculum, elicited and evaluated brief, perfunctory answers. She herself spoke at length about a change in the color, length, and laundry requirements of smocks that people wear on the job—a change we didn't see the significance of—and when one worker attempted to explain why workers objected to not being able to wash their own smocks, Gladis rushed on. We thought it too bad indeed that there seemed to be so little time for reflection in the training room, for there would certainly be precious little on the shop floor. An even more important opportunity for meaningful discussion and reflection was lost during the segment which focused on the memo written by the Governor of New York, in which he objected to the loss of jobs by boat builders and harness makers that would occur if trains took the place of canals. If there is a fear that governs the work lives of people at Teamco and other front-line employees in the Silicon Valley, it is the threat of jobs disappearing through lay-offs or through companies moving away. What a wonderful moment this could have been, if participants had been able to compare the situations of workers during the early 1800's with their own situations today, and go beyond the simplistic and hard-hearted stance offered through the curriculum that all change is good. A brilliant moment for critical literacy on the part of instructor and students, but it was lost. Hoang's observation about parrots seems appropriate here; just about the only response that was valued or permitted in class was a repetition of the expected.

The observations we've made about the individual class on "Accepting Change" hold for the other fourteen weeks of instruction that we observed. Some of the content was more conducive to self-direction and worker empowerment, such as the unit on finance and on problem solving, but the organization of the class, the participant structures, the activities, the literacy practices, the roles available to participants remained the same. It is important, however, not to lay the blame of a class like "Accepting Change" or the others at the feet of an individual teacher. Our observations suggest that many instructors had workers' best interests at heart; indeed, some of them attempted to circumvent or embellish the curriculum, especially in the operation of actual team meetings. However, these instructors were in the grip of a curriculum and corporate-imposed timelines and guidelines that gave them little leeway. In addition, the instructors were former engineers or administrative assistants or production supervisors who had had no formal training as teachers, just the brief seminars offered by Teamco's training department. And this department, like those of many large corporations, looked to national vendors who specialize in quality enhancement programs for most of its curriculum units, a practice that suggests that Teamco's curriculum is no anomaly in corporate training.

We should note, too, that workers experienced the curriculum in a range of ways. Juan was definitely the most enthusiastic worker that we came in contact with in regard to SDWT training. Others like Aurelia enjoyed the chance to practice English, even to do something a bit different from the run-of-the-mill factory day. But much more frequent were the skeptics, workers who doubted the promise of teams. As one young man put it, "Talk [about SDWTs in classes] doesn't match reality." Workers quickly noticed that the power differential didn't shift very much on the floor with the advent of team training. Not surprisingly, many workers seemed fairly jaded about the whole enterprise, as reflected in their jokes regarding their team-related accomplishments: "I guess they'll make me a supervisor, now," laughed one worker whose classroom solution to an exercise was praised by the instructor. And then there were was a small group of workers for whom the curriculum in all likelihood couldn't matter a whit, for they understood very little of it due to their rudimentary English. Once during a team meeting a worker who was a fluent speaker of English complained about having to carry the heaviest burden for team-related duties when others on the team had graduated from SDWT training just as he had. "Ah," said the wise team leader, "but that does not mean that they know."

So, what social identities were suggested through the curriculum, and what new social practices were valued? For a small minority like Juan, the team concept must have brought hope for new, more responsible roles as Teamco employees, roles that allowed more initiative and different, more challenging and promising work practices. We think that Juan is an outlier, however, and that the majority of workers departed from the curriculum the same workers they had been when they entered the training room door. They came and went as front-line employees who understood the importance of hierarchy at Teamco and their own places in it at the bottom of the heap. They understood that the training program signaled that new demands were about to be made upon them, including attending team meetings and increasing production, but they easily assimilated these new demands into their existing notions of work at Teamco.

TEAMCO: TEAM MEETINGS—A TRILOGY

After attending many weeks of SDWT classes, we as researchers were eager to get to the factory floor and to observe team meetings in action. As educators we understood how difficult it is to imagine and enact a liberatory curriculum when traditional conceptions of schooling are all that most of us have experienced. And we had a sense of the time pressures and production constraints that curriculum developers and corporate leaders were working within. We had great expectations, then, that once workers were turned out of school, they would be able to accomplish a great deal more than had been apparent or expected of them in the classroom. And to a large extent we were right, as the next section will show. However, in the same ways that traditional notions of workers' roles and identities hobbled the curriculum, they also put constraints on the operations of teams and the literate practices that were a part of team meetings and related activities.

The first glimpse we had of the factory itself was through a picture window near the training room. This impression, later confirmed, was that Teamco presented a brighter, cleaner, shinier version of circuit board assembly than did EMCO. This industry did not operate within the stringent cleanliness requirements of, say, chip manufacturers, where workers are robed from head to foot; nonetheless, Teamco stood out as particularly tidy and orderly, testimony perhaps to its conscientious implementation of the Japanese "5S" system, and evidence certainly of the company's sense of itself as an industry icon. The actual layout of the shop floor, on the other hand, looked a lot like that of EMCO and other circuit board plants: First came the rows of expensive surface mount machines, robots programmed to affix tiny components precisely to bare boards. These were followed by more people-intensive areas, where workers did component loading, mechanical assembly, and touch-up, all by hand. At the back of the building were the Testing department, materials and kitting, and shipping. As is common in industrial plants, there were no windows bordering the floor. One of the first questions we were usually asked when we arrived on the floor, then, was about the outside: "Is it still raining? Is it real hot today?"

The factory floor was neatly diagrammed with yellow and black tape to indicate the borders beyond which you were not allowed to walk if you weren't wearing a smock and electro-static guards on your shoes. Interspersed among the lines of machines and work areas were computer terminals and filing cabinets which housed the all-important directions on how to assemble the boards, manufacturing process instructions or MPIs. Lining one side of the shop floor were open, movable cubicles, the natural habitat of managers, supervisors, and engineers. On the walls of these cubicles, facing the factory floor, were numerous graphs, charts, and numerical summaries describing the productivity and quality scores for every team in the building. There were also pictures of the teams which had won the building's "team of the month" competition. Clad in white smocks and shod with electro-static devices, workers stood by the robots, monitoring the assembly process, or sat at tables or in front of assembly-line-like work spaces performing their handwork. Walking among them you are apt to hear rapid-fire Chinese and Vietnamese as workers converse with each other, and heavily accented, halting English when they speak to you. Occasionally a tall white manager will walk down the broad aisle next to the cubicles, a jarring site indeed amidst this workforce of Vietnamese, Taiwanese, Chinese, Filipinos, and other people of color.

Teams corresponded to work areas. That is, all the people who worked in shipping were on one team, all those in a Hand-Load line were on another, those in Touch-Up on another, and so on. Officially, each team was supposed to meet for one-half hour a week, every week, although this varied greatly in practice. For instance, one team from the Test department met unfailingly each Monday at 7:00 a.m. for an hour. We were aware, however, of other teams which met sporadically or only for our benefit, and others which have yet to meet at all. Some supervisors or coaches, we soon learned, were less than enthusiastic about the team concept, and "hot jobs" or a heavy production schedule were apt to take precedence over meetings. When they did happen, team meetings took place in a variety of places, partly dependent on the size of the team. Large teams of twenty people or so commandeered the training room, while smaller ones crowded into a cubicled conference room that abutted the factory floor, or they held their meetings at a table in the noisy cafeteria adjacent to the cubicles but off the factory floor.

Officially, team meetings were supposed to be conducted according to certain criteria. There was supposed to be a team leader and a minutes taker, and there always were in the meetings that we observed. These jobs were to rotate among members, which sometimes happened and sometimes didn't. The team leader was not supposed to be the same person as the lead worker on the line or in an area, although this was sometimes the case, as we will see below. (Ironically, there weren't supposed to be lead workers at all; these positions had been abolished with the advent of teams, when authority and responsibility on the floor were to be shared among all workers. However, in practice, leads were still leads and were recognized as such.) Each team had a binder in which minutes were recorded on pre-printed forms. There was supposed to be an agenda for each meeting, and there were recommended forms of participation, such as brainstorming and saying "pass" if you had nothing to report. And perhaps most importantly, team members were expected to engage in a "seven-step problem solving process," which had been covered in the SDWT curriculum. By means of this process, workers were supposed to analyze the causes of problems in their areas (through the use of fishbone diagrams and Pareto charts and such), implement and evaluate a solution, and measure the results—activities which certainly required considerable expertise with literacy, mathematics, and language, not to mention knowledge of manufacturing. Later, during building and plant-wide competitions, selected individual teams were expected to present the results of their problem-solving activities to management; they were judged then on their presentation style as well their results.

One other team activity is worth previewing before we eavesdrop on some actual team meetings. Shortly after we began our observations of teams, management announced plans to link self-directed work teams directly to productivity and quality results, and these results to compensation. This was done by requiring all teams to set specific quality and productivity goals for each fiscal quarter—that is, each team completed a form containing graphs of their previous quality and productivity percentages and a rationale for their future goals—and by rewarding those who met their goals with a bonus. Team leaders were expected to compute quality and productivity on a daily basis, to record these scores daily in a computer program with a security system (to prevent cheating), and to report back to the team, so that problems affecting their scores might be solved. Then, at the end of the quarter, the money available for bonuses would be divided equally among teams who had met their goals; those who had not met their goals would receive nothing. There was naturally some interest and worry on the part of workers about this new system. In the past, bonuses of varying amounts had simply appeared in the pay envelope of some individuals. Under the old system the rationale for determining bonuses was never made explicit, though everyone had a theory—it's how much overtime you're willing to put in or it's how well you get along with your supervisor. With the advent of teams, individual performance would cease to be rewarded in favor of the team unit; no matter how hard an individual might work, his fortunes would rise or fall with those of his team. It follows, then, that one important potential activity for team meetings would be setting goals and monitoring weekly performance on quality and productivity, with an eye toward determining whether or not team performance was likely to result in a team bonus.

It would be impossible to choose a typical team or a typical team meeting to present here, for there was such great variety at Teamco. Some teams seemed to model themselves on SDWT training or management meetings, with a person at the front of the room directing the meeting in a formal way, while others were much more casual, eschewing an agenda or rules for participation. Sometimes supervisors (now called coaches) took an active part in the meetings of the teams in their areas, and sometimes they didn't. Teams varied as well according to ethnicity, gender, and the education and work experience of participants, mainly because teams were organized by department or work area. Some departments (such as Test) required more education of their workers than did others, some were known to be places primarily for female workers (like Hand-Load), while others were segregated by ethnicity (recall that the Touch-Up area where Aurelia and Hoang worked was predominately Vietnamese). Some of these distinctions, by the way, were driven by the values and beliefs of workers, who constructed and enforced culturally-based notions of what constitutes an appropriate job in terms of gender and ethnicity. Thus, to capture something of the variety of the teams we observed, we will next present narratives of three team meetings, representing three different teams and three different work areas in the plant. The _first_ team meeting will be presented in some detail and two others more briefly.

Team #1: Acon

The first team we will examine is from "Hand-Load," an entry-level area of the plant which doesn't require much training, although all employees in this area must take "basic electronics" at Teamco Tech once they become permanent hires. Workers in this area place components on boards by hand. This work begins when a line is assigned a batch of boards from a customer (such as Intel or Hewlett-Packard or 3Com). The lead decides how to partition the work among the six people in her line, that is, how many and what kind of components the first person in the line will load, etc. The boards are pushed from one end of the line to the other, with each worker incrementally adding a different set of components. In front of each worker is a color-coded diagram, indicating schematically which parts should go where. The last person on the line is the "QC," or quality control; she inspects the work done by the others and when necessary refers to a set of "manufacturing process instructions," the major document on the floor, as does the lead. Written by engineers, these instructions describe what workers are supposed to do in each factory department or area in order to assemble a given circuit board. After inspection the QC loads the boards onto a cart, and they are wheeled off to the next department. While the others are assembling and inspecting the parts, the lead worker continues to organize the work, trouble-shoot, or help out on the line. The pace is intense; there are time standards for each board and contradictory pressures on the workers, given team goals, both to work faster and to work cleaner, increasing productivity and decreasing defects.

This Hand-Load team, which called itself "Acon," after a major customer, consisted of seven women, several of whom we will introduce below. The first two team members, Xuan and Eva, play a big role in the team meeting that we will soon discuss.

- Xuan is of Chinese heritage. She grew up in Vietnam and speaks Vietnamese as well as Cantonese fluently, but lacks confidence in her English, which she began to acquire when she arrived in the US four years ago. Young, in her twenties, she is small and soft-spoken, and although she is the lead of her Hand-Load line and in charge of her team's meetings as well, she often has trouble influencing the workers to participate in team activities. The supervisor of the Hand-Load lines reports that Xuan has no desire to promote, but we noticed that Xuan has ungrudgingly taken on more and more responsibilities regarding teams and their reporting requirements and that she had become quite adept at the growing paperwork surrounding goal-setting.

She also used every opportunity to learn English, although shyly. Her team has the best quality and productivity scores of the Hand-Load area, with almost perfect quality scores, or zero defects, and productivity that sometimes ranged over 100 percent. Xuan is engaged to be married; she and her fiancé are planning a traditional Chinese wedding celebration at a local restaurant in the coming year.

- Eva, the most recent hire in Xuan's Hand-Load line, is originally from the Philippines. Her English is very, very good, and because of this, she is the informal spokesperson for the team, despite the fact that Xuan is its leader and Eva, the most recent hire. Eva was also responsible on most occasions for taking minutes during the meetings. Married with two children, she often commented that she has two jobs, one at Teamco and one when she goes home to be a wife and mother. Eva was hired as a temporary, as are all workers at Teamco, and during the time that we knew her, she was very proactive in attempting to be made permanent. When all the other members of her line refused to take on the tedious, eye-straining job of quality inspector, she eventually volunteered for it, for the supervisor had hinted broadly that it would help her chances. Although she claimed to be afraid to talk to the supervisor and often asked the researchers to intervene on her behalf, Eva was quite outspoken at team meetings and on the line, so much so, in fact, that she regularly offended some of her co-workers. Eva was made permanent about five months after she was first hired, much earlier than is the norm.

- Chet Sing is from Burma and misses her homeland very much, having left most of her family there a few years ago. She is the person most offended by Eva's loud comments about defects on the boards. Her most extended conversations with the researchers concerned her dismay, anger, and hurt at being blamed for quality problems that she didn't cause. Extremely quiet during team meetings, she rarely participated but appeared to listen intently and to understand everything.

- Mrs. Lee, the oldest member of the team, is also its pariah, sitting off to one side during meetings and rarely interacting with her coworkers on the line. She is rumored to be rich and to work at the factory as a hobby, and she is much maligned by the other workers for her failure to cooperate and for being too slow at her work. Mrs. Lee sometimes punctuated team meetings with loud bursts of complaints, spoken in such heavily accented and rapid English that it sounded Chinese. During these moments the team members would alternately ignore her, laugh, or roll their eyes.

- Irma, a Filipina, is the mother of two grown daughters and a five year own son, the pictures of whom she keeps in a plastic cube at her work station (a practice prohibited for safety and neatness' sake). Her husband is American-born; she met him in the Philippines. Irene doesn't take part in the meetings and often refuses team-related requests, such as taking minutes or thinking about goals at home. She seems, in fact, disinterested in work and resentful of efforts to engage her more fully in team-related activities. However, she understands the monetary implications of goal-setting quite well, and she also calculates her overtime pay precisely, comparing her check to those of her co-workers. She and Eva sit next to each other on the line and on occasion speak Tagalog to each other.

- Lan is the young supervisor/coach of the Acon team and three other Hand-Load lines. In her late twenties, small, and pretty, she is a dynamo on the floor, rushing about, directing the work in rapid Vietnamese or determined English, furiously filling out paperwork, afraid of no one but feared by many. Lan immigrated to the US from Vietnam in 1989, and lives in San Juan with her parents and three siblings. She got a job at Teamco shortly after arriving, started out in Hand-Load, and then was promoted to lead. About one year ago she was promoted to supervisor and said at that time she didn't know much about what to do, but has since then learned a lot on her own. Lan takes classes at a local community college in ESL, computers, and fashion design; she hopes eventually to be an engineer. She would also like to get married someday, but rejects many of the traditional Chinese values of her parents, particularly their notions of saving money. Lately she has changed her name, dropping "Lan" and taking "Monique."

The meeting we will examine here took place after the Acon team had been meeting regularly for four months. Most, but not all of the team members had completed SDWT training; one notable exception is Eva, who was a recent hire and still classified as a temporary employee ineligible for the training. The meeting was held in the cafeteria at 2:00 p.m., one hour before day shift ended, and while workers from various departments were milling about the room. All the participants described above plus a few others were present with the exception of Lan the supervisor, who preferred to let the teams run on their own, especially since a researcher was present who, she assumed, could help a bit with calculations, etc. The researcher had attended almost every meeting of the Acon team thus far, had gotten to know everyone, and was viewed by most as a friendly resource, someone who could be trusted to give advice about the operation of the team and someone to whom it was safe to complain.

As we did earlier with the transcript of the classroom lesson, we will present here a summary of the team meeting punctuated with excerpts of actual talk, the intent being to give a vivid account of what the meeting was like. The questions to keep in mind during this section include: What does this meeting suggest about the identities workers are constructing as team members? That is, what patterns of talking, acting, and valuing are apparent, what social practices? And how might we describe the literate demands of such meetings and workers' responses to them? That is, how are these demands embedded within the company's experiment with teams, and how do workers meet those demands, circumvent, or shape them?

This meeting of the Acon team began, as did they all, with our exodus from the shop floor to the cafeteria. Team leader Xuan went round from station to station quietly but insistently announcing in a high-pitched voice, "Team meeting, team meeting!" The researchers walked with Eva, as was our custom, for she enjoyed providing quick summaries of what had been happening the previous week. Eva confided that she had given Lan the supervisor an "ultimatum" about being made permanent. When we asked what she had told her exactly, Eva confessed that she had written her a note, being afraid to speak to her face-to-face, and that she had explained she would have to leave Teamco were she not made permanent soon. The group gathered around a cafeteria table in the usual manner, with Xuan and Eva at one end next to the researchers, the others grouped near us, and Mrs. Lee some distance away. The first part of the meeting was a recital of the week's problems, common fare for any Hand-Load line. There was the big board which required each person on the line to load fifty-nine components apiece, and the additional problem of having had twenty of these boards returned to the line because certain parts had been reversed. There was the problem on another board of "mixed parts," the mistaken use of one part, which is the same size and same color as another but which has a different value, and the problem with "bent legs," the disturbance of the tiny wires protruding from components that fit down into the board. Here is an excerpt:

Eva: [to researcher] Oh we're having a hard time doing the Lexicon, the big board. The one Lan told you had more than three hundred components

Xuan: Three seventy-five.

Eva: One person you have to load fifty-nine components at every station.

Researcher: One person?

Eva: We spent two hours finding our own location.

[Much laughter]

Xuan: Yeah ( ) the location, one minute, the other side [miming with her hands finding the locations on the board]

Eva: We did about twenty boards from eight to three, and then the next, the following day they returned to us, reverse [meaning the line had made a mistake, putting the parts on in the wrong direction].

[Laughter]

All this talk proceeded casually, with much laughter and joking and with no one taking control of the meeting or enforcing an order of business, though Eva with her good English and strong personality tended to dominate. Interspersed among the discussions of typical hand-load problems were other topics of interest—a startled realization that someone has forgotten to bring the book for taking minutes, a critical observation about the short dress of a cleaning person who walked past the table, a report of a rumor that more lines were soon to be added, a complaint about a noxious smell in the wave area.

After Eva mentioned John, a Filipino worker who said he didn't want to work in the wave area because of the smell, there was a pause of several seconds, until Xuan brought up the issue of productivity. One day the previous week, it seems, their line had had a productivity score of only fifty-five percent, which was below their stated goal for the quarter. Xuan explained that "the lady," by whom she meant the female engineer, thought the calculation might be wrong, that it should be higher, and Eva urged Xuan to make the correction. Xuan stated, however, that it was too late, implying that once recorded, the score couldn't be changed. Here is their exchange (which includes overlapping and interrupted conversational turns, indicated respectively by a dash and by spacing):

Eva: Did you check the lady about the fifty-five percent—

Researcher: Mhm.

Eva: —of what we did ah just any [ ]—

Mai: Just any [ ]?

Eva: And he told you to check it to the lady. So did you check it?

Xuan: Yeah I check already.

Eva: What did she said?

Xuan: She said it might wrong you know because Hand-Load they write in the mechanical ( ) that's why-

Eva: That's what, so how many percent now?

Xuan: (Fifty) percent. [slight pause] You cannot change it.

Eva: Aaaaaahhh.

After this exchange Xuan continued to focus the groups attention on poor productivity, pointing out that one day this current week the line's score was only fifty-seven percent. Eva's agitated question of "why, why, why?" brought a quick and spirited explanation constructed jointly—in fact almost simultaneously—by several people on the team. The complete transcript of this exchange follows, but its gist is this: The Acon line had been asked to load components on a new board, the Acuson, during a period of enforced idleness (the melting machine was down, making their customary boards unavailable). The Acuson was a board ordinarily loaded by another line, and the Acon team wasn't familiar with it. The board was especially complex, requiring twenty-one tiny transistors and much tedious masking. There were only five people on the Acon line to do this work, whereas the line that usually loads this board has seven workers. Nonetheless, the Acon line managed to complete one hundred twenty Acuson boards, working two hours of overtime. And nonetheless, their productivity was below their goal.

We present the following long, rather complex excerpt because it gives the flavor of how talk typically happened in the meeting, although the conversational turns occurred much more quickly—one right after another, after another—than can be suggested on the page. The excerpt also indicates how savvy workers were as a group, even those like Mai, whose spoken English was quite limited and who didn't ordinarily participate much in meetings: They knew precisely why their productivity was low for that day, and could marshal all sorts of details and evidence in support of their explanation, albeit in a somewhat rowdy, random manner.

Researcher: It's still fifty=six=

Xuan: =But= this week- this week had one day is fifty-seven, right?

Woman: =Yeah=

Researcher: =Ah, why?= Ah, why?==

Eva: ==Why?

Xuan: Becau-..us don't have job, right?

Mai: Yeah [rapid speech] (Le-=e-e-e-he)=

Xuan: =Acuson= board

Eva: ==Oh:: yeah==

Mai: ==Acuson board==

Xuan: ==[??]== very slow

Eva: Yeah::

Mai: One hundred twenty

Eva: We did a=

Mai: =wh-=

Eva: =Acuson board I think==

Mai: ==One hour =one hour=

Eva: =Wednesday=

Mai: [rapid speech] Twenty boards =an hour=

Researcher: =Ah, when you= said you did twenty boards =that day=

Woman: =[laughter]=

Researcher: ==Is that the day you're talking about? The day you =did twenty=

Mai: =[???]= First number wa- was =[???]=

Eva: =No, that's= different this week

Researcher: Oh, this week. Oh, oh, oh, =that was last week=

Xuan: =I think we did sixty- twenty boards==

Eva: ==We didn't have boards== because the melting machine was down=

Mai: =[??]=

Eva: =and they let us do the Acuson board, and we spent- I don't know how many hours we did their board

Researcher: Isn't- you don't =usually do Acuson-=

Xuan: =(They give us)= two hour- you're not- overtime two hour they have eighty boards, but us how many, how-==

Mai: ==One hundred twenty

Xuan: One hundred twenty, but how-==how long=

Mai: =how hour=

Xuan: ==How long?

Mai: I don't know how long

Eva: I remember it==

Hoa: ==may- =maybe it's-==

Xuan: ==five hour

Eva: =five hour, yeah=

Mai: =maybe it's five= =maybe five=

Eva: =maybe four to five hour=

Mai: ==maybe so:

All: [laughter; comments in Vietnamese]

Researcher: Why though? I mean-

Eva: Because it's- there so many defect boards=

Woman: =[Vietnamese]

Researcher: You're not used to doing that?==

Eva: ==No, because that's- this is Acuson board==

Researcher: ==Oh:, so you don't =do that Acuson board=

Eva: =it's not our board=

Researcher: It's not =what you=

Eva: =We're just trying= to help it because we don't have any board to do

Researcher: So it took you a long time; that made your productivity low

Eva: Yeah

Researcher: Would- Hmm==

Hoa: ==[high pitched] Yeah

Researcher: So==

Woman: ==[Vietnamese] [.03]

Xuan: Just how- how many person?

Eva: =ten=

Mai: =one=

Woman: [Vietnamese]

Mai: One, two, =three, four,=

Xuan: =Acuson boa-=

Mai: ==five. five==

Xuan: ==five people==

Mai =five people

Xuan: Nah: =[Vietnamese]=

Mai: =five people [Vietnamese]=

Researcher: Oh, Acuson usually has seven==

Mai: ==Yeah [??]

Researcher: And you- just five of you guys

Mai: Yeah =[Vietnamese]=

Xuan: =[Vietnamese]=

Mai: Twenty, twenty, twenty, twenty-one==

Eva: ==transistor- twenty pieces of transistor=

Woman: =Oh::=

Eva: =you have to put masking on it, and=

Researcher: =Oh=

Eva: =[??]=

Xuan: =each one= but it's hard, you know. You need to pick the (straight). If you (fall down) like that you cannot make it==

Eva: ==That's why we're very very slow==

The next topic in the meeting was how to document this problem. Eva stated loudly to Xuan, "You have to put a note on the paper ... you have to give them a reason," meaning that Xuan should take care to write down on their score sheet an explanation for the low productivity score for that particular day. Xuan defended herself, saying she usually writes these things down, but on that day she simply forgot. Eva retorted with spirit that Xuan may have forgotten to write, but she will remember the bonus—and maybe the team won't get one:

Eva: Then you have to make a note at the back and tell tell them the reason why is our productivity is so low that day. So they will give us credit for that==

Xuan: ==I know, yeah, this time I forgot.

Eva: Ay-yai-yai! Oh::

[much laughter all around]

Eva: Did you see every time, did you see every time we have a meeting or something else I put a note on my paper?

Xuan: Yeah==

Eva: ==Yeah you have to do that all the time.

(17 related turns omitted)

Xuan: I write a note already.

Researcher: Good.

Xuan: But that Acuson I forget [laugh].

Researcher: [laugh] You forgot the Acuson.

[Much laughter]

Researcher: Okay [.02]

Eva: You'll remember the bonus ( ).

[Much laughter]

Eva: [teasingly] Maybe we don't receive any.

[Much laughter]

The meeting began to wind down. Eva asked jokingly whether anyone had been fighting—"everybody fighting?"—a reference to the rather steady history of conflicts between Mrs. Lee and the rest. Mrs. Lee responded that "everybody tired," which prompted a whispered conversation about Mrs. Lee's rumored wealth and some raucous comments on what she could do about her high blood pressure. Eva then turned the conversation one last time back to their productivity for the week, asking Xuan "how many percent we have this week?" Although she didn't have the numbers at hand, Xuan with help from the team was able to reconstruct from memory their scores for the first three days of the week: seventy-seven percent on Monday, the infamous fifty-seven percent on Tuesday, and seventy-five percent on Wednesday. The data hadn't been analyzed for Thursday, but the group felt confident that their score was fine for that day. The researcher averaged these data and reported that their score was sixty-nine percent thus far for the week, well above their quarterly goal of sixty percent. Xuan then consulted a little black notebook that she always carried in her pocket and announced that for the entire quarter thus far their productivity average was 82%, but that their quality was poor and still a problem. No one comments. The half hour set aside for the meeting has passed, and the Acon team wandered back to the floor, chatting in groups of two and three as they walked.

This meeting of the Acon team certainly does not fit usual notions of a formal meeting, at least the notions of those accustomed to some variation on Robert's Rules of Order. Nor does it abide by the guidelines set up by Teamco through its SDWT curriculum. There's no agenda, there's no apparent order of events. There's no problem solving a la fishbone diagrams and Pareto charts or any other reminder of the SDWT classes. There's no one really in charge. People wander in and out of the conversation, paying attention to what interests them, ignoring the rest. Talk is simultaneous, overlapping, and latched, as one person repeats the words of the current speaker or finishes someone else's sentence or interrupts or talks on top of another. There is much laughter and joking. One of the researchers, who had lived in Southeast Asia and speaks fluent Vietnamese, told us that the meetings transported him to Vietnam, that the participants were very "close" to that culture, not yet being completely Americanized, and that they seemed to draw on common Vietnamese participant structures. It seemed to us, as well, that there was something reminiscent here of kitchen-table conversations among women everywhere, something most of us have witnessed or experienced.

Although the meeting may appear chaotic, and some of the members less than cooperative and others supremely unaware of Teamco's "Basic Principles," it is important to note that some important work of the team was getting done. One can point, for example, to the litany of hand-load problems at the beginning of the meeting, dutifully noted in the minutes—reversed parts on board number 158294, bent legs on number 4929194—a significant step in identifying the line's quality problems. Then there is the jointly constructed explanation for their low productivity on one particular day—they were working on a complex board foreign to them, and their line was short the requisite workers; this explanation allowed them to account for a problem if not to fix it. And then there is the Acon team's discussion of how to document these extenuating circumstances so as not to be penalized on their productivity record and ultimately their team-based bonus—team-worthy activities, all. The fact that so much work was accomplished in this informal, folksy gathering, and that there was participation by workers who did not speak in other forums that we observed, makes one wary of imposed notions of what counts as a good meeting. Indeed, we witnessed less lively, more dreary gatherings of other teams that did abide by the letter of the law for how to conduct a meeting but accomplished less.

Another indication that the Acon workers were acquiring the sensibilities to operate as a team is their attention to documentation. The enormous reporting apparatus associated with productivity and quality scores for teams—alluded to in the above transcript, especially in Eva's comments—underlines the increasing role of literacy in this factory and the ways in which writing, reading, and computation took their place in day-to-day work events. Every week, it seemed, engineers or supervisors would invent a new form or revise an old one, most of them designed to enforce careful recording and analysis of data collected on productivity and quality rates. The data were then transferred to computer programs, which generated the myriad graphs and charts that lined the cubicle walls. For the most part, leads buckled down and mastered the massive new reporting requirements, attending the meetings in which new forms and methods of calculation were introduced, computing their scores and filling out their forms each day after work with a bottle of "white-out" nearby, and acquiring the technological sophistication needed to wade through and modify vast computerized data bases. They also groaned—"no, not another form! so much paper!"—and noted that the paperwork was an additional burden in an already burdened work day. Workers were also quick to notice the ways they could turn paperwork to their advantage. Eva's zeal to write down explanations for the team's low productivity is a good example. Xuan's little black book of important numbers and facts is another. And when faced with strict reporting requirements that rigidly divided the day and the work into unworkable segments, workers learned to fudge, altering what they reported so that it would fit the forms.

One could say, then, that a part of the new working identities of people on the front-lines at Teamco had much to do with literacy and numeracy. All of a sudden, not only were hand-loaders expected to be quick and accurate at their work, they were also, with the advent of teams and new systems of reporting and monitoring, supposed to conceptualize their work differently. They were now to include as part of it an understanding of goals, goal-setting, calculations, and reports, and all the literate acts these activities entail. Put another way, workers were asked to conceive of themselves, not just as employees who performed the physical act of placing components on a board, but also as thinkers, as people who monitored their own hand-loading rates, reflected on and analyzed their problems, and reported the same through print and through presentations.

Team #2: Quality Assurance

The Acon team certainly represents the most relaxed end of the team meeting spectrum in terms of the formality of talk and interaction among participants. Team 11, known as Super Five (named for its five separate lines on the work floor), also maintained a relatively relaxed meeting style. However, the sheer number of participants (twenty-three in all) seemed to dictate a more established meeting format in which turns at talk were distributed largely by the supervisor, and the meeting agenda was followed fairly closely. Still, the Super Five team held significantly less formal meetings than many of the other teams we observed, in which only leads and supervisors held the floor and where a more presentational, less exchange-oriented mood pervaded during the meetings. A close look at one of Team 11's meetings illustrates an environment in which informality and respect for protocol seemed to co-exist comfortably.

On a Wednesday afternoon in mid-April at 3:00 p.m., which marked the end of day shift, a group of twenty-three workers clad in white, knee-length company jackets, all members of Team 11, convened in a cramped conference area out on the factory floor. The meeting room consists of several five-foot-high, moveable cubicle walls which enclose an oblong conference table big enough to seat ten to twelve workers comfortably. This team, however, the Final Mechanical/Final Quality Assurance (QA) team, is large enough to necessitate a ring of standing workers who encircled those seated around the table. As team members arrived each one picked ~~up~~ a copy of the meeting minutes and agenda stacked neatly in a pile at the end of the table nearest the entry. While they waited for the meeting to begin, they quietly perused the two-page document. Rachel Solarzano, the Team 11 supervisor, sat with pen in hand, making notes—reminders to herself about important issues that needed to be taken up with the group. An employee of European American descent in her mid-thirties, Rachel had worked at Teamco for just over two years. While she is deeply committed to the company, she is also devoted to those whose work she oversees. Rachel often acknowledged the stress associated with a new plant procedure, the Continuous Flow Manufacturing (CFM) process, and she made a point of praising employees' hard work during team meetings, telling them how much she appreciated their efforts, and promising that they would reap the benefits of their labor when bonuses were distributed.

As the room became increasingly full, Rachel allocated space to individuals, asking those on the sides to move back in order to make room for everyone. When all members of the team were present, she asked QA lead April Nguyen, a rather shy Vietnamese woman with graying hair, to read the minutes from the previous week and the agenda for the current meeting. April read aloud to the group, and team members followed along with her on the copies they held in their hands. A review of the minutes and agenda was followed by a request from Rachel for reports from three members of the Final Mechanical/Final QA line on problems in their respective areas that they felt were worthy of the team's attention.

In accented English heavily influenced by his Japanese roots, Toshio Kogawa animatedly described difficulties with boards coming from another line—Second Hand-Load. Toshio and his co-workers were getting boards with a tilted component, which is problematic because it conflicts with the Manufacturing Process Instructions (MPIs). In this particular case the MPI indicated that the component must be soldered flush with the board, but Toshio tells Rachel that the boards often arrive at Final Mechanical in a state that doesn't comply with protocol—a situation which warrants finding a way to solve this ongoing problem. The following excerpt from Rachel and Toshio's conversation is typical in terms of the manner in which problems are presented in the context of Team 11 meetings, and provides a sense of the kinds of exchanges that occur between this team supervisor and the line workers. The turns are often latched and overlapped, which reflects the relaxed feel of the meetings (although they are more formal than the kitchen-table conversation of the Acon Team), and the exchange also gives some indication of the significant kinds of language learning opportunities that occur regularly in the work context.

Toshio: E:h we got problem on uh 606? Eh? So Second Hand-Load they got push their ICs up. They're connected here [motioning with his hands]. The xxx push by the middle [.02] push down the part.

Rachel: Okay so what you're saying is =the ICs=

Toshio: =xx this way. Yeah=

Rachel: =are tilted?==

Toshio: ==Yeah. Still high.==

Rachel: ==So the leads weren't flush =into the board?=

Toshio: =yeah= the two side xxxxx. /Rachel: Okay/ The xx

Rachel: Socket

Toshio: Socket. Yeah. That's a problem.

Rachel: They were sticking out of the socket /Toshio: Yeah/ On one side, right?==

Toshio: ==Yeah. And the other one is uh 653? The CPU the locking system? /Rachel: um hm/ sometimes xxx. Looks like it just sometimes not very x not very hard==

Rachel: ==So they're not locking it correctly?==

Toshio: ==No locking correctly, but uh CPUs uh still one side high one side down.

Rachel: OK.

Toshio: Different. That's a problem.

Rachel: So those are the two major things that you found, =right?=

Toshio: =yeah.=

Through Rachel and Toshio's lively exchange, peppered with hand gestures which mimic the physical relationship of the component to the board, the two came to a clear verbal understanding of what the problem is. Rachel then thanked Toshio for bringing it to her attention, and she promised to look into it.

Following Toshio's report Binh Tran, a young, soft spoken Vietnamese worker on the Final Mechanical line, stepped forward to give an account of difficulties in his area. As he did so, he reached into his pocket and pulled out a piece of paper from which he read for the duration of his presentation to the team. The group listened attentively while Binh listed the difficulties he is aware of, and minutes taker Carlotta Bonilla, a Filipina in her early twenties who works in the QA area, took notes assiduously. When Binh had finished, several members of the group lightly applauded his thorough account, and Rachel thanked him. Jorge Garcia, a middle-aged Mexican-American worker from Final Mechanical, also reported on problems. He informed the team that his line was getting boards with loose nuts or without nuts and washers at all. Rachel queried him, wondering if he or the lead for his area, Magdalena, had been communicating about this issue with the First Mechanical line, whose work precedes that of Final Mechanical. (Such communication between lines takes place both verbally and in writing, sometimes in the form of a Corrective Action form—a written document which is customarily filled out when a specific problem occurs repeatedly.) Again, the following excerpt gives a sense of the kind of talk that occurs in Team 11 meetings.

Rachel: Jorge?

Jorge: Yes mam.

Rachel: Did you have anything for us? It was your turn /Jorge: Oh yeah/ for the type of defects that you were finding on the LTX product?

Jorge: Yes uh on the LTX board we found uh [.02] there's a lot a loose nuts on the side stiffener. They're almost always loose that's a continuous uh problem. Always loose. And most of the time they find some that have no nuts and no washer at all. They're just missing completely.

Rachel: And this is coming from =First Mechanical?=

Jorge: =Yeah= First Mechanical.

Rachel: Okay is this being are are you guys feeding this back to them? Is there feedback where they're knowing the problem is existing or have you guys done anything do you know if Magdalena's letting them know?==

Jorge: ==I have I don't know if she's been letting them know but she's goin' over there and brought the the==

Rachel: ==takin' them to show them?==

Jorge: ==The material. No she's brought the material xx==

Rachel: ==The material?==

Jorge: ==Managed to xx.

Rachel: Okay. So we need to check that with her.

Jorge: 'Cause they uh 'cause they changed from uh a innertube washer to a uh split washer we've had a lot a problems 'cause uh they've been tightening over tightening the bolt which causes the split washer to open and get pushed out.==

Rachel: ==So it's just kind of [.01] comes off?

Joyce: Yeah it comes off.

(4 turns omitted)

Jorge: So then we gotta take it all off and then find another one or find a xxxxxxxxx. You know. That's that's one of the things that's that's wrong with xx.==

Rachel: ==So that's what you =found.=

Jorge: =Yeah.=

Rachel: Okay. Well that's good.

This meeting obviously provided workers with ways of participating in the problem-solving process by bringing problems to their supervisor's attention. However, it is significant that it is most often the lead or supervisor who 'looks into' the difficulty, and who ultimately has the power to solve problems—to affect changes—out on the floor. Although technically the advent of teams meant that there were no longer leads out on the floor, when Rachel asked Jorge whether Magdalena (an unofficial lead for Jorge's area) had spoken with the other line about the nuts and washers problem, it is clear that, functionally, such differential positions of power persist.

When the three individuals' comments from Final Mechanical were complete, Delores Aguilar, a health and safety inspector of Mexican-American descent and also a member of Team 11, read the Customer Satisfaction Index (CSI) report to the group. This report, which comes weekly from Teamco's customers, "grades" the company on quality, communication, and delivery. This day, as on most days, the report consisted of mostly A's and B's. The CSI report was followed by the 5S report (a health and safety report) which Delores also reads to the group.

Following the CSI and 5S reports, it was the supervisor's turn to take up issues that she believed important. She reiterated her expectation that all team members would be at team meetings on time unless they had a customer to attend to or there was an emergency. Rachel commended the team for their hard work and their disciplined approach. She asked if everyone was using the Total Quality Management (TQM) forms passed out at the last meeting, and Delores suggested that they spend some time discussing TQM. Rachel explained that the leads (there are five individuals who act as leads on Team 11) are supposed to fill out the forms indicating what the most important things are that workers seem to be missing. The new forms and tracking that TQM requires mark an increase in the literate responsibilities of workers that has occurred recently with the shift to teams.

Moving on through her own list of agenda items, Rachel informed the group that all the permanent employees' performance reviews were done, and that they (the management) were working on making some of the temporary workers permanent—something most temporary employees desired as this entails receiving health and other benefits, and, in general, higher pay. As temporary employees joined the ranks of the permanent workers, they too would receive regular reviews, Rachel says. She emphasized how important their work as temps was to the process of becoming permanent, and thus encouraged them to try to "do good" because their first review would be based largely on their performance as temps. As supervisor, she reminded them that she needs to know about vacations so that she can schedule accordingly. Jorge from Final Mechanical, who had been at Teamco for less than six months, asked about the possibility of taking off one day of personal leave, but after some discussion it is pointed out that this is for permanent employees only—temps are not entitled to this time off. Finally, Rachel reported on the problems that there have been recently with labels on one type of board. These boards in particular have an unusually large number of labels, and so extra care must be taken by the team to check that labels have been placed correctly. She reminded them that both in meetings and out on the floor they need to speak up if they do not understand something rather than nod (as if they do) or guess about a procedure. In part, the purpose of team meetings was to provide a formal medium for discussing such questions and problems.

April, QA lead, brought up the need to repair CPU's on certain boards. Although this should not be happening, she explained that they need to be unbent on the line. The roving inspector, Delores, pointed out that this is precisely the kind of information she needs to receive from the team so that she can make a point of auditing the areas that seem to be having the most difficulties.

As the meeting came to a close, Final Mechanical lead Joyce Castro, a Filipina in her late forties who taught first grade for twenty years in the Philippines before coming to the United States, offered some advice to her fellow workers. She told the team that if an individual found him- or herself with nothing to do, then he or she should come see one of the leads, who would in turn find a job that needs doing. "So you have to tell us you have nothing to do. 'Give me a job. You got a job for me?' Don't just go home and say there's nothing to do." That this is occurring comes as a surprise to Rachel, who commented that the worst thing is to clock out and go home without being paid for the full eight hours. Even if it means doing paper work in her office, she said, there is always something which needs to be done, so be sure to check with either her or one of the leads before leaving Teamco for the day. She reminded people that although Team 11 is divided into five lines by customer, that technically everyone should be able to work anywhere in the Team 11 area (although in general individuals stay at one work station and do the same job rather than work at different tasks). She urged any individual who had a desire to cross-train for another line within the Team 11 domain to speak with her so that she can arrange for them to be cross-trained. She reminded them that M.T. Ming (the building manager) "totally backs up the fact that we need to cross train. So if you're interested in learning something else you can cross-train within our area. Just come and see me and I can cross train you with some other person. And everybody has to be happy about it because eventually it's gonna happen anyway. The more you learn the better off you are to the company," said Rachel.

The meeting described here is typical of the weekly meetings held by Team 11 in its uses of literacy, its opportunities for language learning, and the problem solving that the workers are invited to participate in at Teamco. Although a high percentage of the workforce is comprised of non-native speakers of English, reading and writing in English and problem solving are part and parcel of what workers do at Teamco everyday. They read and write meeting minutes and agendas, they receive important information from both customers as well as from internal sources about their team performance, out on the work floor they must refer to the Manufacturing Process Instructions for a wide range of different boards made by the company, and they must also document defects as a means of tracking their quality and productivity, using the data they collect to keep a running tab of team performance on a weekly basis. Workers order parts from the stockroom by filling out order forms, and they have to keep track of how many and what kinds of boards are finished by their line and are then sent to shipping. Some individuals are responsible for more specialized literacy tasks such as keeping track of inventory on the computer, and entering data which will eventually be used by the team to calculate their goals for the upcoming quarter. Clearly, a wide range of literacy skills is employed by workers at Teamco on a daily basis.

Since so many of the workers speak English as a second language, interactions occurring in English—whether spoken or written—present an opportunity for language learning. Toshio and Rachel's exchange (described above) in which talk and gesture are co-mingled, typifies the kind of linguistic assistance and opportunities for increasing language skills that employees have access to everyday. Because the workforce represents such a variety of cultures and languages, English (written and spoken) is used by everyone as the common language of the workplace. While workers of similar background can often be heard conversing in their native language, and many workers also write notes to themselves and one another in their native languages, they are not only able, but are obligated, to function in English according to the literacy demands, and the needs for cross-team and cross-area communication at Teamco.

In addition to being a literacy-rich, and linguistically rich environment, as indicated above, Teamco is also a place where workers must be able to problem solve on the job in a variety of ways. The accounts of Toshio, Binh and Jorge demonstrate how important identifying problems is to the team process, but problems are not simply the subject of reports to the team; rather they constitute an integral part of the daily work life of Teamco employees. Negotiation between team members and across teams is as important as being able to discuss the accuracy of the Manufacturing Process Instructions with the engineers who design them, and sometimes matching the schemata with the actual parts and boards proves to be a challenge, as Toshio's report above illustrates. Doing what the job requires is not always as simple as it appears to be, and often making reality (boards, for example) conform to the required specifications takes an enormous amount of ingenuity as well as an informed appreciation of the problem.

However, at the same time that there is considerable effort to involve line workers in the problem-solving processes of the workplace, there are also constraints on the ways in which workers can participate in such activities. This is illustrated on Team 11 by the fact that while Toshio, Binh and Jorge are sincerely appreciated for bringing problems to their supervisor's attention, they are not in positions to actually affect the changes necessary to solve the problems they perceive, but must instead rely on the leads and supervisor to consult with other lines within the factory. In this sense, the traditional hierarchy is once again maintained, as it was with the Acon team.

Team Meeting #3: Wave Solder

We turn to the swing shift's Wave Solder team for our third and final—and most formal—example of a team meeting. Because this meeting deals first with a particular work event and then a particular work process problem, it will be helpful if before presenting the narrative of the meeting we introduce the four dominant figures in the meeting and out on the production floor—the technician, lead, most senior operator, and supervisor—and then get an overview of Wave Solder, the area and the process.

- Carlos is the Wave Solder technician and one of the members of the building's SDWT Goal Review Board. A Filipino in his late 30's, Carlos has been with Teamco for eight years. He began in the wave area, catching boards, was soon made lead, and has been technician for two years now. As technician, he's responsible for maintaining the machines, monitoring their settings, and helping the operators with any technical or process problems. There are no engineers on swing shift, so Carlos serves as a liaison between the engineers and the operators, coming in early to meet with the engineers or to pursue issues with the day shift operators and technician. Carlos has also taken on the unofficial role of team facilitator. Made the leader of the team by the supervisor when SDWTs first were implemented, Carlos served in that capacity for the first five months of team meetings. Although he wanted to rotate the position, get others involved as lead and minute taker, his teammates were reluctant to take on the roles and voiced their confidence in the job he was doing. Among other reasons they offered for his staying on as leader was his facility with English. Aside from that, it didn't help that when Carlos left for a month for his annual trip back to the Philippines to visit his wife and children, the team met only once. That meeting was so painfully silent that the team voted that night—the only action taken—not to meet again until Carlos came back. A month after Carlos returned, however, he told the team that he would not be leader any longer. According to his understanding of a team, he had told the group, everyone should share in the leadership roles. He agreed to help whoever became the new leader, but he would no longer be it. And with that announcement, he left his seat in the front of the room and sat among the rest of the team members. With Carlos' guidance—actually, because of his abdication, they had little choice—the team decided upon a plan (they drew straws) for rotating the duties of leadership, with each member serving a four-week stint as minute-taker, then moving into the role of leader for another four weeks. Beyond the team process—in fact, as part of a program almost antithetical to the team process—Carlos has also submitted two detailed ideas to the company's employee suggestion program—one a plan to standardize the width and thickness of the fixtures in order to minimize set-up time for different assemblies, the other a system for recovering good, useable solder unavoidably removed when operators clean the dross from the top of the solder reservoir in the wave machine twice each shift. Both ideas were accepted and will yield Carlos a percentage of one year's savings resulting from implementation of the ideas (which could be substantial, given that before implementing this second idea, the building went through one ton of solder every seven days; now a ton will last nineteen days).

- Dai, a Vietnamese man in his early 30's, is the area lead. He has been in the US six years and has worked at Teamco for five. Like Carlos and each of the operators, he started as a board catcher in the wave area, then worked as an operator. He was promoted to the area lead a year earlier, when Carlos was promoted to technician. Dai is a soft-spoken man of a few thousand words. That many of the other Vietnamese workers, not to mention the Chinese, Filipino and Latino workers, have some difficulty understanding Dai's heavily accented English doesn't stop him from speaking confidently and at length in most of the meetings. In fact, if the following meeting varies from the norm, it is in the limited number and length of conversational turns Dai takes. Unlike many of his teammates, Dai feels comfortable in the role of team leader—so comfortable, in fact, that when Leon was serving as team leader and Dai was filling in for an absent minute-taker, Leon felt a need to stop the meeting at one point and remind Dai who was the leader. By virtue of his position as area lead, Dai appointed himself to fill in for Carlos as team leader during that fateful month when Carlos returned to the Philippines. He had felt the team should continue to meet in Carlos' absence, but his was the only vote cast in that direction. Dai is taking ESL courses at a local community college and plans to enroll in electronics courses which will enable him to become an engineer.

- Leon, a Filipino in his late 30's, has been with Teamco since he came to the US three years ago. He started in wave as a board catcher and moved up to wave machine operator after one year. These two years as operator make him the most senior of the three wave machine operators on swing shift. Leon studied electronics during his one year of college in the Philippines, but he was disappointed in the classes and says he learned "almost nothing because only theory, nothing practical. Not like here. You know, I'm used to learning in practical but not in theory, because sometimes I'm not too much believe in theory. You cannot find the problem in studying theory, you can find a practical way, right?" When his girlfriend (now his wife) told him she was pregnant, he decided to give up his basketball scholarship (he was a point guard), drop out of college and go to work to support his child. He worked as a nurse's assistant in an intensive care unit in Saudi Arabia for a while, then alternated between helping in his older brother's law office in the Philippines and managing the subdivision and sale of a large chunk of real estate his father left him and his fourteen brothers and sisters when he died. Like Carlos, Leon would like to return to the Philippines and be with his wife and children full time, but for now, the work at Teamco is too good to pass up, with all the overtime and especially since his raise at the last review—he received a $1.50 an hour raise, so he is now earning $8.25 an hour. According to Leon the biggest change since the company implemented SDWTs was that "now too much regulations. (Management) want all the regulation, you know, obey only the leads." This, however, goes against his notion of teamwork, which he often shares with others in the area: "Do not await the orders, the superior, right? (...) Just find your job. That's the teamwork, that's the teamwork." He is pleased with one significant change since the advent of SDWTs: "Before, they (management) talk only to the leader of the division. (Now) they will come to me directly. So I explain why I get problem like that. I can change my ability to work: 'Oh, I have a problem like that, I will change, I will work hard.'"

- Mr. Po is Chinese, perhaps 50 years old, one of three production supervisors on swing shift and the coach of the Wave Solder team. He earned a degree in paleontological botany from a university in China. He had published some scholarly papers, read the work of researchers in the US, and he came to the United States some fourteen years ago, hoping to pursue advanced study at UCLA or Berkeley or some place back east. He notes that a couple of schools offered him scholarships, but not enough to support his family. On top of that, he was worried about his English. Although he could read journal articles in English, German and French, he didn't feel (and still doesn't) that he could speak English well enough to survive in school. He wanted to take study English for a year or so, but he couldn't afford to and thus went to work—with Teamco. He's been with the company since it was just a one-building plant in its infancy, starting in much the same capacity then as he finds himself in now—a manufacturing supervisor. Mr. Po is quiet in the meetings and quiet out on the production floor. Commenting on Mr. Po's role, Carlos said, "He's the supervisor and the company made the supervisor as coaches. So they they have no right to interfere. They're not running the meetings. They have no right to interfere. But they will excuse themselves if they have something to say very important. But if it's not important they just leave us alone." Mr. Po's contributions usually run along the line of admonitions, at times passing along in general terms the quality and productivity concerns he has heard from management, at other times passing along in no uncertain terms the pressures he has felt from management. Though he says little, what he says carries great weight. His comments are laced with "We musts" or "We cannot's" or "This become the rule." While he readily granted us permission to video the Wave Solder meetings, he initially said "no" to the taping of the swing shift Hand-Load team, commenting that they were "not worthy" of being video taped. He holds strongly to the belief that a team's level of success is directly related to the educational level of the participants. Not a strong supporter of SDWTs, he has resigned himself to the fact that they may be here to stay. He sees them more as cosmetic than functional, likening them to a quality award in which the value is in the customer's perception more than in any real change in the process.

Wave Solder—a mechanical means for soldering *en masse* the legs or "leads" of through-hole components—represents a midpoint both in the geography of this plant and in the manufacturing process. The three wave solder machines, or "lines," the wash machine and the two solder pot stations which together make up Wave Solder, are located against the building's long south wall, opposite the administrative cubicles, and midway between the areas which mark the start (Prepping, SMT, Auto-Insertion, Mechanical Assembly and Hand-Load) and the end (Touch-Up, Test, Final Mechanical and Shipping) of the circuit board assembly process.

Boards ready for wave soldering are wheeled over by the cartful from Hand-Load and left in the Wave Solder WIP (Work in Process) area, an eight-foot by twenty-foot section of the floor marked off by yellow tape near the three wave machines and the wash machine. The wave machines—each about four feet wide, six feet tall, and sixteen feet long—and the wash machine—similar in dimensions to the wave machines but resembling a long, loud industrial dish washer with side windows—hide a clutter of boxes filled with bars of lead solder, a black barrel for disposing of solder dross skimmed off the solder reservoir of each machine twice a shift, metal storage lockers, a cart of assorted fixtures waiting to be taken back to a storage rack, and carts and carts of boards lined up for the solder pot, which the carts block from view. The area whines with machine noise, and the air is heavy and hot and smells of molten lead. Leon, one of the wave machine operators, noted that "many people they don't like to work here, they think is a little bit risky. It's hot, always exposed to the lead or to the fumes, so most of the people they don't like to work here." When the air in the area gets heavier than usual, maybe even a little smoky, a machine operator will fetch a step ladder and climb up to change the filters in the ventilation ducts rising out of the tops of the machines. From time to time the wash machine's pump malfunctions, and a couple workers will grab a string mop and a shop vacuum and set to work on a sudsy puddle spreading out from under the machine. More mechanical, less automated, certainly less tidy than the roboticized SMT lines, Wave Solder comes as close to our stereotyped notions of an "industrial" look and smell as any operation in this high-tech plant.

The wave process begins when an operator, seated at the head of the wave solder machine, places the board in a rigid, heat-resistant frame or "fixture"—sometimes only one, sometimes as many as four boards to a fixture, depending on the size and shape of the board—and then places the fixture on the conveyor[7] that feeds into the machine. Any surface-mount components which have already been soldered to the bottom side of a board and any other components which are not intended to be soldered must be protected, so either these components are masked with a special tape prior to waving, or the board is placed in a fixture designed to expose only certain areas on the bottom of the board. The leads left exposed for soldering must first be fluxed. In the machine in line A, the conveyor carries the board over a bubbling fountain of flux which wets the exposed underside of the board. In the other two machines, lines B and C, the fluxer is actually a distinct unit hinged to the front end of the wave machine. The board enters the fluxer and then stops while a spray nozzle, which sounds like a hyperactive ink-jet printer, makes a few passes back and forth, spraying the underside of the board to flux the leads. (Though a board takes longer to get through the fluxer on lines B and C than it does to pass over the fountain on line A, the standard time for running a board is based on line A.) On all machines, lines A, B and C, the board continues after being fluxed into the pre-heat section of the machine, which gradually heats the board to a specified temperature so it won't warp when it passes over the wave of molten solder. The bottom of the board just barely contacts the smooth wave of solder as it passes over, and the solder adheres to the fluxed metal leads of the through-hole components.

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[7] This conveyor is not on a "belt" but a set of "fingers" that holds the fixture along its edge. When viewed from the side, a new finger looks like a capital "L"; old fingers in need of replacement look like a flaccid "L," having been bent through use from 90 degrees to 120 or 130 degrees. At the very least, these flaccid fingers can cause the fixture to hit the wave at an angle, which in turn can cause uneven soldering of the leads. Even worse, boards can slip out of the "grasp" of old, flaccid fingers and fall into the reservoir of molten solder, necessitating time-consuming rework if not ruining some components on the board. Such was the case on the night of this meeting, when two boards Leon was running "caught a wave" and ended up in the reservoir. Why the boards dumped became a topic in the meeting.

At the start of the shift, after consulting the schedule board and the shift supervisor, the lead worker in the area tells the machine operators which boards they will run this night. The operators may already have spoken with the operators on the previous shift to see how the machines are running, if there are any glitches, if required repairs or adjustments have been made, and which assemblies (boards) have been giving them what kind of trouble, although the different shifts may or may not be running the same assemblies.

Once informed of the scheduled assemblies, the operators consult a notebook filled with profiles, one for each of the assemblies. These profiles, written and revised only by engineers , specify the machine settings for each assembly: width, height and speed of the conveyor, pre-heat temperature, solder temperature, and wave action. Most of these settings are in terms of specific ranges rather than absolutes, meaning that an operator can't take the settings for granted but instead must carefully inspect the first board (or "first article") through the process and then adjust the settings based on this inspection. On occasion, the operator will find conditions which aren't accounted for in the profile and must determine, either on his own or with the help of the technician or engineer, what action to take. When running a first article, this first of a particular batch of boards, the operator will get up and wander along the side of the machine, looking through the windows in the side of the machine's lid or hood to monitor the progress of the board, perhaps opening the hood for a better view. The board moves slowly, taking approximately five or six minutes to run the length of the machine.

After running the first article and making the necessary adjustments, the operator must enter in the operator's log book the amount of time spent setting up for assemblies. Over the course of the shift, he will also enter quantity and assembly number of boards waved; amount of time spent running those assemblies; amount of time doing machine maintenance or attending team meetings and so on. This information was supposed to be used by an industrial engineer to calculate standard time—the time it is expected a particular work process will take, by which the actual time taken will be divided to determine the operator's productivity. At the time of this meeting, however, set-up time and first article inspection were not calculated into the standard time. These steps, so critical to quality control, actually counted against an operator's productivity.

Once the operator is satisfied with the adjustments, he is ready for a production run and will now rely on feedback from the person catching boards at the end of the wave machine and the Quality Control inspector (QC), who pulls boards at random to inspect under the microscope. The worker catching the board as it exits the machine removes it from the fixture, checks that the components didn't lift or tilt during the process, and "reads" the solder connections on the underside of the board—specifically, the catcher is to keep alert for missing or insufficient solder, solder "bridges," and solder balls, or beads of excess solder. Any of these will necessitate rework and will require the operator to adjust the machine settings, perhaps the conveyor height or speed, the amount of flux, the preheat temperature or the solder temperature. After inspecting the board, the catcher stamps the board with his or her inspection stamp coded to identify the worker, the line and the shift (the operator and QC also apply their own stamps at their stations). The boards are then put in a rack and, when the rack is full, taken over to line A to be run through the wash machine.

Line A, the wave machine closest to the main production floor, is joined by an open metal conveyor to the wash machine. Since most, though not all, boards which go through the wave process are also sent through the wash machine, this station, the junction between the wave and the wash, is a busy place. The board catcher on line A not only has to catch the boards as they come out of the wave, remove them from their fixtures, inspect them, and then place them on the conveyor that sends them through the wash, but he or she also receives carts and totes and racks and trays full of boards from the touch-up lines and the other two wave machines and sends them through the wash. In turn, the person who catches boards at the end of the wash line is kept even busier. This person catches boards as they came out of the wash, inspects them more generally, especially for missing parts, parts which may have fallen off in the wash, puts them on trays, the trays into carts, wheels the carts to the WIP area, runs back to the end of the line just in time to catch a board off the conveyor before it falls on the floor, and then starts loading up another cart.

The meeting we'll now consider took place late in the evening on the last Tuesday of May. The team had shifted its normal meeting time back from Monday night because of the Memorial Day holiday, even though nearly all of the shift worked each day of the three-day weekend, putting in overtime as they had throughout most of the busy quarter. In the weeks leading up to this meeting, the team had received word from management that the team must dramatically reduce their WIP inventory (the number of boards left in the Work in Process area at the end of the shift). The next week they got word that their quality had dropped, and the drop had been attributed to an operator's tinkering with the profiles, which led Mr. Po, supervisor team coach, to admonish the group to spend more time and to take more care examining first articles and never, under any circumstances, to change a profile:

> Even we know that the profile there's something wrong? Don't do any more. We cannot change any any profile, okay? This become the rule. Nobody can broken, nobody can change the- if the manager find any problem, we change the process, we change the rule? We get a warning or get a fire. Right away. Okay? Because now manager always concern a quality.

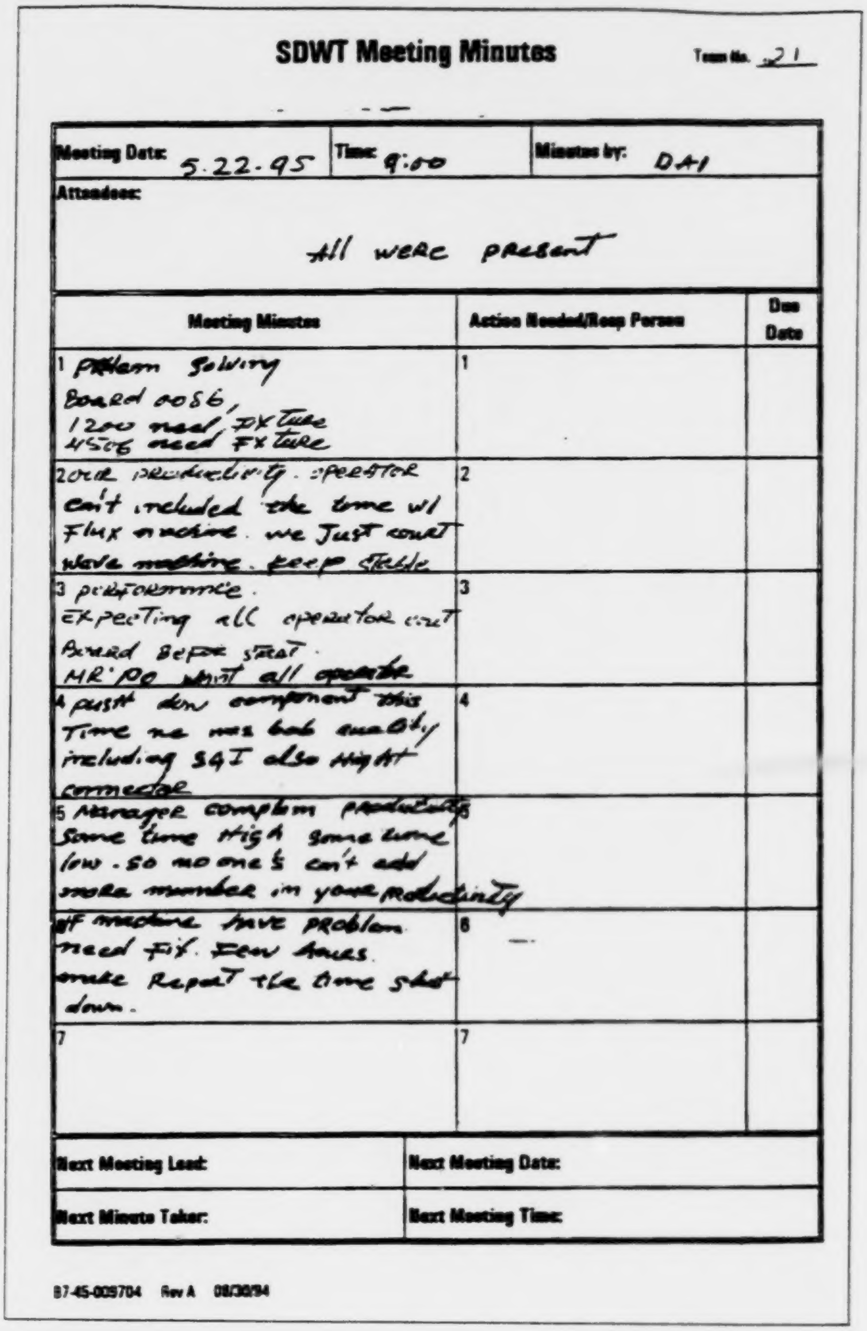
And then the following week, the week right before the meeting we are about to examine, management relayed a concern that productivity was unstable again.

It was just past 9:00 p.m. when the last of the Wave Solder team filed into the Ivory Room just off the production floor, next to the buyers' and marketers' cubicles, always empty this time of night. This is the largest and most formal of the building's off-floor meeting spaces, the same square meeting and training room where the SDWT classes were held. The team members took seats along the middle and back row of tables (recall from the earlier section on training classes that the tables in this room are arranged like a capital "E").

The swing shift Wave Solder team had always maintained a sort of Zone of Leadership, with the minute-taker and leader sitting at the front table, apart from and facing the rest of the team and near Mr. Po, who always sat in the upper left corner of the "E." However, the start of this particular meeting found Hoang, the wave area QC and current team lead, sitting out among the masses, at the end of the middle row of tables. Usually jovial and talkative, Hoang, a Vietnamese woman in her 30's, had been quiet all night on the production floor. Carlos, sitting down the table to Hoang's left, looked at her, his mouth open in mock disbelief. He looked at Dai, the minute-taker seated at the front table by himself, looked back at Hoang, then pointed to the empty chair by Dai and asked, "Who's..? I thought this- it's not teamwork!" Hoang tried to respond but her hoarse voice was inaudible. She had laryngitis. Carlos assured her that "you don't have to talk" but reminded her that "this is your last week," a reference to this meeting being the fourth of the four during which Hoang was to preside as team leader under the rotating-leader design the team agreed upon earlier in the year when Carlos announced he was not Leader for Life, no matter what they thought. When again Hoang gestured that she couldn't talk and showed no sign of moving, Carlos began to plead: "That's OK. That's OK, go over there. Please. Please." At this point Dai suggested that Carlos "forget her because she has lost, she kinda sick today. So I be here for last meeting." Carlos resigned himself to Dai's solution but added, smiling, "Um how 'bout next week? She go up there again."

Having successfully helped Hoang turn aside Carlos' entreaties, Dai willingly accepted the dual role of minute-taker and leader (a role he was always quick and willing to assume) and formally began the meeting. If at times the Wave Solder team stuck more closely to the SDWT guidelines for running a meeting than did the Acon and QA teams, this was perhaps due to Carlos' efforts at facilitating the meetings, even when he sat beyond the front table, outside the Zone of Leadership, as we will see in the following excerpt. But Carlos' off-stage direction allowed room to maneuver: Dai worked from his own meeting script, which differed ever so slightly from Carlos'; and the minutes from the previous meeting were not simply read but collaborativly constructed and reconstructed in the reading, with Leon and Carlos joining in to confirm, expand, update and question the contents of the minutes (see Figure 14 for a copy of these minutes). Also, notice in the final section of the reading of the minutes the summary of the pressures which not only dominated a month's worth of meetings leading up to this one, and which were to become the focus once again in this meeting, but which also were the force behind the company-wide drive toward teams: "We want better quality. (…) The manager complain about productivity." Dai's minutes further highlighted the continuing drive toward greater accountability and monitoring, for workers making note of every minute of their time: "If machine have problems need fix, fill out, even one minute, get it down so we what going on."

Figure 14: Wave Team's Minutes of Previous Meeting



SDWT Meeting Minutes

Team No. 21

Meeting Date: 5.22.95	**Time:** 9:00	**Minutes by:** DAI
Attendees: All were present		

Meeting Minutes	Action Needed/Resp Person	Due Date
1 Problem solving Board 0056, 1200 need FXture 4506 need FXture	1	
2 our productivity. operator can't included the time w/ Flux machine. we Just count wave machine. keep stable	2	
3 performance. Expecting all operator count Board before start. MR Po want all operator	3	
4 push down component this Time we was bad quality including S4I also Hight connector	4	
5 Manager complain productivity Some time High some time low. so no one's can't add more number in your productivity	5	
6 If machine have problem need fix. Few hours make Report the time shut down.	6 —	
7	7	

Next Meeting Lead:	**Next Meeting Date:**
Next Minute Taker:	**Next Meeting Time:**

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Dai: Meeting today we uh==

Carlos: ==Last week.

Dai: No. Today we, ~~how~~ many member we absent, three.

Carlos: 'kay, three.

Dai: Yeah, Ngoc um

Juan: Dinh. =Genaro, and Ngoc=

Dai: =Genaro, and Ngoc. And==

Carlos: ==Dinh.

Dai: Dinh. So all the member we have now. Now I review last week. [Here he begins to read and talk from the minutes in the team binder in front of him. See Figure 14] Last week the meeting we talk about problem solving. And the board from the ( ) zero zero eighty-six. We talk about finding the IC.

Leon: Mhmm.

Dai: But for all the wave we didn't have any problem any more.

Leon: Yeah because we solve already the problem.

Dai: Yeah. We solve them. Then the board, 3Com two one thousand two, I think they need a fixture but I don't know if it's here.

Carlos: Yeah, I told to Jorge Tucker already.

Dai: And 3Com four five zero six also.

Leon: The other one, too. Seven oh four.

Carlos: Yeah, seven oh four.

Leon: We need more fixture for that assembly. Only five. We need two or three more fixture.

Dai: Then our productivity, operators cannot be good every time wash machine, go to ( ) and back. We just count the machine the wave only. Give ( ) Then accepting all operator must count board before they start. Mr. Po want all operators put their component any time. We want better quality from the line. In loading SGI also high connectors sometime. The manager complain about productivity. Sometime high, sometimes low. So no ( ) productivity. If the machine have problem needs fix, fill out, even one minute, get it down so we what going on. Please report the times right away to supervisor. So that's last meeting's minutes.

Carlos: What's our agenda for tonight?

Dai had no written agenda this night, and in place of this formal agenda he offered a general assessment of work processes in the area, noting that there didn't appear to be any problems and that the productivity trend the past week had been stable: "Productivity not going down but not going up." In an oblique reference to the two boards that took a dive into the solder reservoir on his line earlier in the evening, Leon jokingly disagreed: "No, my productivity today tonight going down." Dai ignored Leon's comment, repeated his assessment of the week's productivity, and gave it his stamp of approval, his blessing: "Not going too fast, nothing too slow. Is good. Is very good."

Hoping to elicit agenda items, since he had no agenda, Dai asked the team, "So, you don't have confusion, you don't have any questions, what?" After a silence of several seconds, he tried to engage the team in idle chat, asking if everybody enjoyed the holiday. Carlos reminded Dai that he was the only one of the group who took the time off, who didn't work overtime. Dai laughed nervously and after another silence singled out Juan, asking him if there were any problems back in the solder pot area. Juan responded with a succinct, "Is good right now. Is OK." As Dai began to ask for general comments from the team, Leon interrupted, initiating a serious discussion of the problem he had just joked about. Trying to point out how the problem was tied to procedures in another area, he asks Dai to speak to the workers in that area to make sure they understood the importance of taking better care in applying masking to the board, that a poor job in their area could cause him a lot of quality problems—specifically, if the tape was loose, it could catch the wave of solder, pulling the board off the conveyor and into the reservoir. Dai okayed

Leon's request, and the room fell silent again. Carlos nudged Dai by asking, "So. What do we do?"—perhaps a request to know what was next on the agenda Dai was inventing, or perhaps a hint that Dai might pursue Leon's problem a bit more. Dai seems to have presumed the latter. He began to suggest that if Leon were to look more closely at the board before he loaded it into the machine, he could fix the masking himself and thus avoid the problem, but Leon rejected this notion even before Dai could finish, and again he asked Dai to inform the people who prepped the board that they were not taking due care. Carlos supported Leon, telling Dai, "Better to feed back to Hand-Load." Pushing the possibility that there may have been other reasons for Leon's problem with this particular assembly, Dai invoked the company's Rule of Universal Fixtures—that is, he reminded Leon that when no fixture is specified in the profile, he should use a universal fixture, not run the boards through the machine without a fixture. Universal fixtures are adjustable (and inconvenient) metal frames which can add as much as thirty seconds to the loading time per board and thus dramatically drop the operator's recorded productivity. Leon countered by explaining that the conveyor fingers on his machine were replaced recently—in other words, he was suggesting that as long as the conveyor had new fingers, he should have been able to run a board without a fixture, provided the board had been prepped carefully. If all went well, then, this waving without a universal fixture would yield Leon acceptable quality without sacrificing productivity.

Dai: So anyone have any-

Leon: No, I have a suggestion.

Dai: Sure.

Leon: Could you please remind uh whoever do that to put the tape, you know the masking tape in the in the gold finger? You know? They put the tape very loose. That's why when I wave now without fixture? You know? The board fell down two times. That's my problem.

Dai: Okay.

[.02]

Carlos: [to Dai] So. What do we do?

Dai: You can see it when you put board

Leon: No, better to talk to the=

Carlos: =Better feed back to Hand-Load=

Leon: =who did that uh job, because to remind them that they need to to tight masking tape in the the you know the board.

Dai: But then actually, you know, 3Com sixty-five sixty-nine=

Leon: =Uh huh=

Dai: =all the 3Com fixture, they not, you know, expect to wave like that either. Remember to use universal fixture. ( ) Set for board. Engineer, they not allow you to wave any kind of board without fixture.

Leon: But but that that uh board, there's no fixture, right?

Dai: Yes, right. That's when we use universal fixture. If because now we try to wave like wave ( ) and not set for board, board overflow, whatever? We think because we adjust it with your eye how much () you have. But sometime like happening like two board dump. ( ) whenever and now we==

Leon: ==No, no. I try to wave without fixture that you know that assembly, you know? Because the finger now in the Electrovert, they change already.

Dai: Oh ( ) already?

Leon: Uh huh. Yeah. It's good now. That's why I wave without fixture.

Dai: That's um I think from Hand-Load problem, not from First Mechanical.

Leon: Really? That's why I ask you to .. to remind them.

Dai: Sure. I will.

Carlos: Yeah, I relay the problem already. Tonight.

And so, some seventeen turns after Dai had said he would relay Leon's message about the masking problem, Carlos let Dai know that he had already taken care of the problem. Leon now took one more opportunity to justify his defiance of the Rule of Universal Fixtures:

Leon: Even uh even I use a universal fixture, you know, if they put too much tape, we have problem too because some board have missing because of the thickness of the, yeah.

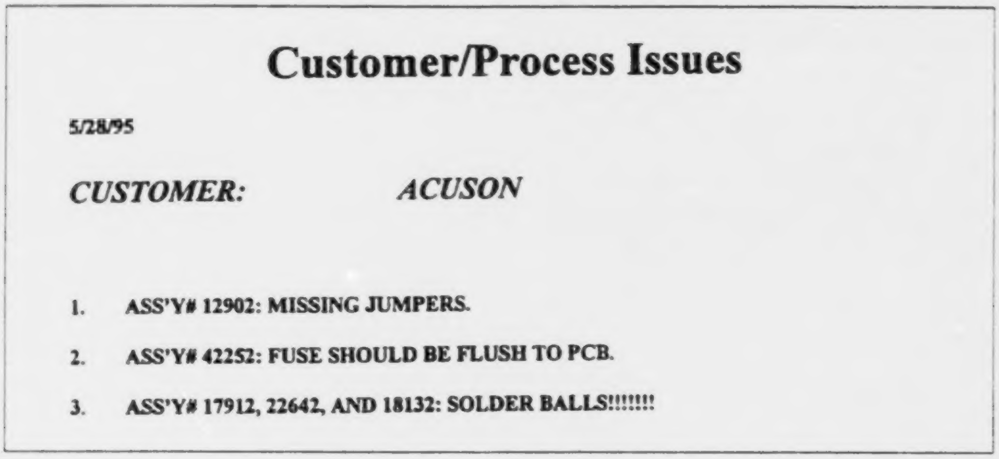
Dai Yeah. Let's see. Does anybody have any question to ask?

Dai effectively ended the discussion by moving to take up further questions from the team rather than to comment on Leon's claim that quality problems don't automatically disappear with the use of universal fixtures.

The only members to speak in the meeting to this point were Leon, Dai and Carlos—typical of the pattern of participation in this team's meetings. The rest of the team, as usual, remained quiet and appeared to listen—although that was no easy task, especially sitting in a warm room this late into the shift after a long weekend of overtime. In fact, Yiheng, seated next to Leon in the back row, began to nod off. (Yiheng is Chinese, in his early 30's and is the least proficient speaker of English on the Wave Solder team.) Dai noticed the dozing Yiheng and called out for him to wake up. Carlos turned to Yiheng, now awake and sipping his tea, and informed him of a "solder ball" problem brought to light earlier in the day during the building's weekly quality meeting, a meeting attended primarily by supervisors, technicians, and engineers. Carlos asked Dai to pull the quality report out of the team binder so he could confirm the number of the assembly with the recurring problem. With the report in hand, Carlos read the one-line problem statement from the report (see Figure 15). As he began to read, he held the paper out to the side as if for others to read along with him, using his finger to underline words as he read:

> Lemme see. [flipping through report] Uh .. we have, every week we have uh weekly quality meeting uh here in this room, so this afternoon we have a meeting with uh everybody on line and I'll show you Acuson problem. [finding page he'd been looking for] Acuson. Yeah. "Assembly seventeen nine one two, two two six four two, and eighteen one three two. Solder balls."

Figure 15: Report of Quality Issues Referred to During Wave Team Meeting



Customer/Process Issues

5/28/95

CUSTOMER: ***ACUSON***

1. **ASS'Y# 12902: MISSING JUMPERS.**
2. **ASS'Y# 42252: FUSE SHOULD BE FLUSH TO PCB.**
3. **ASS'Y# 17912, 22642, AND 18132: SOLDER BALLS!!!!!!!**

Carlos handed the report back to Yiheng and Leon. Together they read it silently as Carlos succinctly reviewed what combination of factors can cause solder balls to form on a board during the wave soldering process and what course of action should be taken to correct the problem.

> 'kay. If if you wave that kind of board uh just lower the pressure to ten. 'kay? Yiheng? Because if you have excess flux and uh too fast you will create solder balls because of you not really drying up the flux.

Yiheng affirmed his familiarity with the assembly, reading the number aloud and adding a physical description: "Yeah. Acuson small one." Yiheng and Leon then speculated on what else in this case might have been responsible for the problem, whether it was some step in the process, as Carlos suggested, or some machine components, perhaps a faulty fluxer nozzle or bad conveyor fingers. Carlos acknowledged that they had experienced problems with the fluxer nozzle in the past, but he assured them that this problem has been fixed. Then, to emphasize that solder balls was a recurring problem, he put the problem in terms of their quarterly quality trend, gesturing to represent a rising and falling graph:

> If this a if it's it's a recurring- recurring problem. If if the customer's, you know, the customer give back have a ~~feed~~back and then the graph would show like we have solder balls and then and then uh Acuson comes over here and says, "Well what's happening," and then drops. After a while again, we have solder balls again. So it's doing like the same cycle so if we can you know control the flux of 'specially this type of boards.

Carlos asked Hoang, the QC, to be especially careful in checking these three assemblies. She responded, hoarsely, "Show me" and reached out her hand for the report, which she perused as the conversation continued. Leon asked Yiheng a few questions about his process, then made some suggestions, excerpted below. As he made these suggestions, he mimed the process: First he mimed with one hand a board moving along the conveyor, and with the other the spray nozzle passing back and forth under the board. Then he mimed lifting the board and, with one finger, "reading" the underside of the board. Finally he mimed the turning of dials.

> Leon: Check the board. After the board passing out of the fluxer nozzle? Check the board. The bottom? Check if the too much flux.
>
> Yiheng: Too flux.
>
> Leon: Uh huh. Too much flux? Adjust the.. that's better.

Carlos suggested to Dai, "Why don't you get a very quick uh..uh fishbone diagram for for the solder balls." Dai gave no indication that he would take Carlos up on the suggestion. Instead, he responded by saying, "I don't think he understand why to have solder balls and why adjust the fluxer down to ten for flux pressure." As Dai launched into an explanation directed at Yiheng, Carlos walked to the front of the room, saying, "Let's make a statement of the problem." He stood at the board behind Dai, waiting for him to finish his explanation. When Dai was done, Carlos said aloud the words "solder balls" as he printed them on the board. Next he drew a fishbone diagram and began to label the different "bones" or categories for possible causes of the problem, saying aloud the words as he labeled the categories. After labeling three categories, he stopped and asked for help. Leon and Juan obliged him:

Carlos: So we have people, the system, the machine ... what more? People =the system=

Leon: =Materials=

Carlos: Material. [writes "Material"] Tools. [writes "Tools"] Another one.

Juan: Profile and system the same?

Carlos: System, huh?

Juan: Profile the same, right?

Carlos: Oh, profile is for the machine.

Dai: ( )

Carlos: Tool, and material.

The categories Carlos listed were the same as those taught in the SDWT classes and found on the fishbone diagrams created by other teams. Unable to remember the final category but noting that "before we have this this fish already," Carlos walked over to Dai's table and consulted the team notebook for a sample of a fishbone diagram the team had constructed during an earlier meeting. He returned to board and completed the labeling by writing "Method" at the end of the last bone. He then pointed in the direction of Leon and Yiheng, two of the three operators (the third was absent this night), and asked, "What what are the causes of solder balls?"

What followed was a break from the typical pattern of participation in this team's meetings. We present the following somewhat lengthy excerpt to show how the diagram was collaboratively constructed. Carlos and Leon continued to take the majority of conversational turns, but other team members who up until now had been silent joined in correcting, confirming, and refining their own and others' contributions to the diagram, and hence to their collective understanding of the wave soldering process. During the course of the diagramming, Leon acted as Yiheng's language facilitator, restating spoken and written comments, gesturing or miming for clarification. For his part, Carlos seemed to serve not only as recorder/facilitator, but also as teacher: When Leon and Yiheng offered "Too much flux" as a possible cause, for instance, Carlos repeated it, stretching out the word "flux" and pausing as a teacher might, leaving a linguistic blank for the student to fill in.

Carlos: [pointing to the back row] What what are the causes of solder balls?

Leon: Too much =flux=

Yiheng: =Too much=

Carlos: Too much flux: .. pressure. Where shall we put it .. here [indicating with a wave of his pen the diagram as a whole]

Dai =Method=

Leon: =No, method=

Mr. Po: Method.

Carlos: Method.

Leon: Yeah.

Carlos: [saying out loud as he writes] "Too much flux pressure." Uh we had the standard of ten cc per minute. [writing "STD 10. cc/min"]

Leon: Maybe nozzle problem?

Carlos: Nozzle problem? That's machine. [saying aloud as he writes] "nozzle of the spray fixture"

Leon: Or maybe the they don't uh apply the right uh profile?

Carlos: The right profile? And system. [saying aloud as he writes] "Right profile" And uh the people?

Leon: Yeah, running too fast, right there. That's for the people, or?

Carlos: That would be uh

Leon: Is that the same thing uh right profile?

Carlos: [saying out loud as he writes] "QC"? Uh==

Leon: ==Yeah, QC.

Carlos: "don't see the problem." [pausing to finish writing] Uh operator, what more? [pausing then pointing to Ernesto in back row] Sir. Ernesto.

Ernesto: (inaudible)

Carlos: And uh==

Macario: ==Proper speed of this uh proper speed of the conveyor?

Carlos: Uh huh. Conveyor speed incorrect. So it's a method, Mr. Po?

Mr. Po: Yeah.

Carlos: Incorrect. This is the same thing with the=

Leon: =Right profile=

Carlos: =right profile. Um same. [saying as he writes] "incorrect conveyor speed."

Yiheng: Conveyor speed.

Carlos: Or um right profile if it's include like preheater [beginning to write "1. preheat" under "right profile" on "system" bone]

Leon: Low temperature?

Carlos: Too low. And uh

Yiheng: Sometime flux machine broken, is number only ten, only te- later twenty.

Carlos: Mhmm.

Yiheng: Yeah.

Carlos: So, uh, yeah it's pressure problem, too.

Leon: Nozzle problem. —

Yiheng: Nozzle.

Carlos: Uh, spray problem. [writing "spray flux problem"]

Leon: [to Yiheng] That's why I I ask you to after passing the board? [miming]to the fluxer nozzle? Check==

Yiheng: ==I check, they are very good, later, later move later twenty

Leon: Maybe you maybe you forget. (laughs)

Yiheng: No, I ( ) you check it the same.

Carlos: What more? [pause] I think

Leon: That's enough.

Carlos: So we have we have identified the the cause of solder balls here. So can you understand the the the solution to this problem. 'kay? We have the solution

Leon: We have solution already?

Carlos: One solution solution. [writing "sulotion"] Solution or suggestion.

Leon: Wrong spelling.

Carlos erased the top of the first "o" to make "sulution" and this time heard from both Leon and Macario. He redrew the "u" he had just created out of an "o" and was in turn corrected by Juan and Leon. After a few more attempts and continued corrections, Carlos changed the first "u" to an "o" and thanked the group for their help. Yiheng tried to pronounce the word and again received assistance from Leon, who repeated, "Solution. 'shun' 'shun' 'solu-shun.'"

Carlos' announcement that "We have the solution" had taken Leon a bit by surprise—"We have solution already?" But Carlos explained that they could turn the fishboned causes into a list of solutions, and he offered an example. Macario and Leon quickly joined in as the other team members watched. Ernesto, in the back corner, far from the Zone of Leadership, jotted notes, and Yiheng tried repeating some of Carlos' elaborations:

Carlos: So if you can base the solution with this kind of problem, right? First thing is use the right profile. [saying out loud as he writes in his "solution" column] "1. Use right profile." Number two?

Macario: QC. QC.

Carlos: 'kay?

Leon: Don't know, maybe check the nozzle spray nozzle, you know? Fluxer nozzle?

Carlos: Okay. [writing "2. QC" and then saying aloud] "should check under"=

Macario: =Solder=

Carlos: ="the microscope." 'Cause we cannot see solder balls. Sometimes they're too small, sometimes they're big, 'kay? Uh, so right profile incorporates with pre-heater, incorrect conveyor speed, and especially operator

Yiheng: Check so small.

Carlos: [saying out loud as he writes] "3. always consider first article." 'kay? Before running production. Right? If there is any problem, if there's any problem, you see solder balls? Operator and QC must let me know [writing "4. operator/QC must let tech know"]. Okay? So to avoid solder balls we have at least four solution=

Leon: =solution=

Carlos: =right?

[reading off board] Use the right profile, QC should check under the microscope, always consider first article, operator must let me know right away.__

After Carlos thanked the team and started to walk toward his seat, Juan offered his own summary of the solutions:

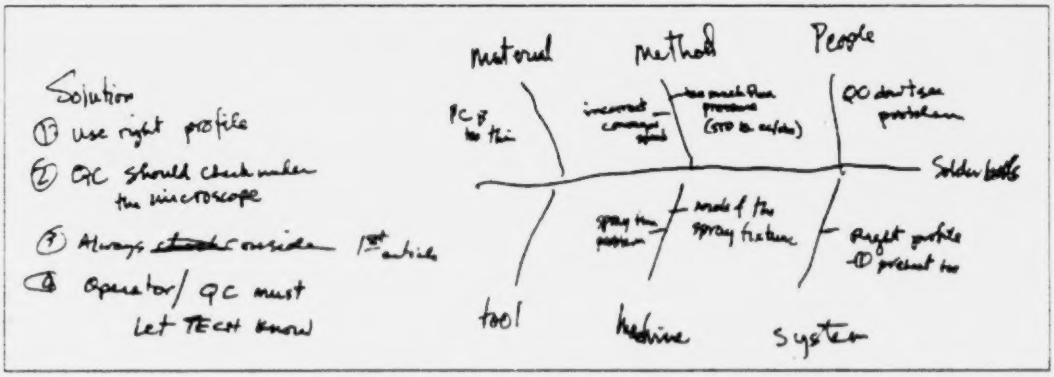
Juan: So the solution is follow the profile.

Carlos: Yep. That's right.

Juan: Just follow the profile.

Once again, Leon assisted Yiheng, this time by reading what had been written on the board, alternately pointing to list and miming the listed items. (See Figure 16 for the fishbone diagram and list of solutions as they appeared on the board.) Juan, still looking at the board, repeated, "Yeah. That's the better solution. Follow the profile." Mr. Po, as if to second Juan's comment, noted, "Also, we need to ( ) highlight the profile. The profile (very important)."

Figure 16: Wave Team's Fishbone Diagram and List of Solutions as They Appeared on Board in Front of Meeting Room


Solution
① use right profile
② QC should check under the microscope
③ Always ~~check~~ consider 1st article
④ Operator/ QC must let TECH know
material
method
People
PCB too thin
incorrect conveyor speed
too much flux pressure (570 [illegible])
QC don't see problem
Solder balls
spray the pattern
mode of the spray fixture
Right profile
present too
tool
machine
system

Dai, who had been copying down the diagram for the meeting minutes, asked the team if they all agreed with the solution, or if they had any questions, to which Carlos

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replied, "If there's something, Mr. Po will talk, (...) before we end, Mr. Po have to talk." As it turned out, Mr. Po did have something to say. He praised the team for its problem-solving process, and again he highlighted the profile:

> Yeah, I think this uh prŏblem sŏlving like this solder ball thing very good is very good example. We need to put these kind of problem to make a highlight of the profile. Okay. When we run this kind of board we need pay more attention so we run it the second time happen with same problem. So this solution very good. This is very good for everybody, we see how to solve the problem.

By now it was 9:30, the team's meeting time was up, and it was time for the last break of the evening. Leon asked what would be on the next week's agenda, to which Yiheng joked, "Next week again"—the same ol' thing. Dai, who would be starting his four-week stint as official team leader the next week, explained that items for the next agenda would be determined by what came up in the next Monday afternoon quality meeting. As a last item of business, Mr. Po offered a reminder of an impending audit by an international standards agency (ISO 9000) and admonished the team to "pay attention about ... everything." He and Carlos both highlighted particular do's and don'ts during an audit:

Mr. Po:	So everybody need to pay attention about the sometime, ESD, safety glasses, ( ), gloves, everything, the process and follow the==
Carlos:	==And also maintenance maintenance log should always be signed before we go.
Mr. Po:	Signed. Signed. You cannot ( ) drink cup and something.

Dai asked for clarification on the day and time when the audit would occur and was told that they "never tell you." At this point Carlos, from his seat outside the Zone of Leadership, adjourned the meeting and the team members wandered out toward the cafeteria.

The wave team made a considerable effort to, as Carlos put it, "Follow the rules of the meeting," to abide by the criteria set out for SDWT meetings. The leader and team members often followed Carlos' promptings to read the minutes, to present an agenda, to formalize a course of action, to present a problem statement and to list solutions. There was a minute-taker and team leader for each meeting, and the team had agreed upon a system for rotating all members through these positions on a monthly basis—no easy task, as we found out observing other teams. They kept the team binder up to date, and if by chance the team leader or minute-taker forgot to write up notes or an agenda, or wrote it up but neglected to put it in the binder the next day, Carlos would remind the guilty party—occasionally in front of the rest of the team, as he had done recently, telling Dai that "after every meeting we should always put the minutes right away in the binder. It's very important because we follow the rules of the meeting." Perhaps because of this attention to rules, the wave team's meetings proceeded slowly, formally, almost self-consciously—an interesting contrast to the sometimes rowdy informality of the Acon meetings: The pace of conversation was slow, more often marked by gaps than overlaps. And in contrast to the animated discussion and lengthy reports from multiple participants in the QA meetings, participation in the wave team meetings was limited and linked to the hierarchy within the production area. That is, conversation was dominated by Carlos, Dai and Leon, the technician, area lead and most senior machine operator, respectively. Others joined in the conversation only when their input was explicitly solicited, as during the formalized problem-solving process.

Carlos' decision to work from a formalized process may or may not have helped the team bring under control the recurring quality problem (they would have to wait for another quality report to determine that because their process did not include a step for collecting follow-up data). But the process did seem to facilitate other kinds of work within the team. For one thing, the formal fishboning called attention to language—comments were repeated, paraphrased and restated as they were written down, corrective feedback was offered on spelling and pronunciation—and this combined with Leon's generous and capable assistance to provide Yiheng in particular with an important opportunity for language learning. The process also began to contribute to the team's increased understanding of the larger manufacturing process, of the ways the company goes about its business, demystifying some of the links between the work the team's production work, the data gathered on that work, the uses made of the data, the customer feedback and team improvement processes. It also offered those who were "board catchers" but who aspired to be operators an opportunity to hear of some of the problems which might befall an operator and to participate in the discussion of the problem and its solution. Without this forum (the team meeting) and this particular process (the fishbone diagram), some of the board catchers were cut off from the operator's end of the process.

Witness silent Ernesto, the note-taking board catcher. A Filipino in his late 50's, Ernesto had been with Teamco for three years but in this building only six months. He had worked in Mechanical Assembly but hoped to be a wave operator soon. Asked about the notes he made each meeting on scraps of paper and kept in his smock, he said simply, "They help me remember." In his position as board catcher on the wash machine, he was farthest removed from the operators. And his job was commonly regarded as the busiest in the area, so he didn't have the other board catchers' luxury of interacting with the operators as they checked first articles or as the board catcher wheeled the carts of fixtures back down the line to the operators. Consequently, he used the meetings as an important way to overcome his isolation, to become more familiar with the various processes along the line, to watch and listen, to take notes, to help himself know and remember.

The uses of literacy in this meeting were characteristic of other Wave Solder meetings. Specifically, the Wave Solder team engaged in literate activities to call themselves into account, to highlight operator error and the need to follow the rules. This stands as an interesting contrast to the Acon team, which discussed ways to use documentation to cover for themselves, especially, to explain their low productivity, and the QA team, with their audit-driven documenting, tracking and reporting. This is not to say that the team hadn't at other times emphasized, as had the Acon team, the need to document their every activity in order to challenge and, they hoped, change unfair time standards—recall, in fact, Dai's call from the previous week's minutes to account for every activity: "Even one minute, get it down so we (know) what going on." But never had the team engaged in a formal brainstorming session in order to elicit all the possible ways, for instance, to accurately assess standard time. Instead, the team's formalized attempts at problem solving were of the sort seen in the meeting above, started in response to an issue brought up in quality meeting, an issue perceived to stem from operator error. The team used the formal procedures, then, to monitor themselves, to remind themselves of the rules to follow—to highlight the profile, so to speak. This is not surprising, since the team is limited in what they have control over: They cannot change the profile, even if it is wrong; they cannot abide a verbal request, for fear of reprisal; they cannot re-calibrate standard times, even if these times are based on incorrect assumptions about machine configuration and work processes. Give these and other limitations,[8] it is no surprise that the team focuses on what they can control: their own behavior, their own competence, their actions within the limits of the profile.

The Wave Solder team's uses of text further highlight some interesting features about literacy in this plant. Like the work in most production departments—as opposed to the QA group, whose auditing and reporting functions foster the production of extended texts—the work of Wave Solder does not rely on the construction and uses of extended texts, but instead on participation in extended literate activities sparked by or linked to minimal texts. Consider how the simple and emphatic single line from the quality report—*ASS'Y #17912, 22642, 18132: Solder Balls!!!!!!*—conjures up a web of work processes, all literate activities. In simply citing the assembly number, Carlos and Yiheng invoked multiple documents, including the profile (and all the power relations entailed in its creation and use), the careful reading of the board which determines the difference between the profile's engineer-specified settings for desired results and the operator-adjusted settings to account for actual results on any given night, the log book (and its separate purposes and attendant power relations), the customer feedback process, the ongoing monitoring of quality and productivity data, and so on.

Reflecting on Teams' Uses of Literacy

People who make their living with language are apt to be pleased with the increased literacy requirements of Teamco, viewing the practices as potentially humanizing or even liberating. At the very least, they are likely to point out, this kind of work is better than the familiar "hire-them-from-the-neck-down" policy that characterized workplaces of old. We would also point out that the competent ways in which workers tackled the mounting paperwork, adapted to the new reporting requirements, and even modified or adjusted or appropriated those requirements in small ways speaks volumes about workers' abilities. The faith of the manager in charge of teams was well placed; these workers rose to the challenge. But let us press a little further, situating the literacy practices that evolved at Teamco within the larger context of work at the factory. When we analyzed transcripts of the Acon meeting and those of other teams, our purpose was two-fold: To understand how literacy was used—who was expected to read and write, in what situations, and for what purposes—and to understand how teams functioned—what was the range of their activities? In what ways were the meetings a forum for solving problems and taking action, and in what ways were team members constrained?

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[8] The teams were built as much on limitations as on possibility, a notion that came clear in the SDWT curriculum (especially in the "Accepting Change" class) as well as in the team binders. Each team's binder contained a two-column sheet titled "SDWT Boundaries," to be filled out by the team. One column was labeled "Can Do," the other "Cannot Do." Typical of the items on the lists were these from one team. "Can Do: Follow schedules; move the WIP to first station; help prepping if we are not busy." "Cannot Do: Cannot work overtime without approval; Cannot talk, eat, discuss perssonal (*sic*) thing on working area & working time; Cannot change MPI with out approval."

One of the codes that we assigned infrequently, in these three meetings and in those of other teams, was "Taking Responsibility," which we defined as "making a decision and acting upon it either individually or as a group." We thought that this category might capture something fundamental to the notion of "self-directed" work teams. But the only example of such an action in the Acon meeting was Eva's description of the letter she wrote to her supervisor asking to be made permanent, and this was an individual action, not a team-based or team-related effort. In the Wave Solder team, it came up only when Carlos said he had passed along Leon's concern to another functional area. A more frequent code in the meetings was "Explaining"—or describing a work situation or work process in such a way as to identify problems—and "Complaining"—or commenting upon a work situation or work process in such a way as to emphasize how it is problematic or in order to assign blame. The list of hand-load quality problems generated at the beginning of the Acon meeting fits the "complaining" category, while the discussion of low productivity we coded as "explaining." "Explaining" was a frequent code in the Wave Solder meeting, also, along with "paraphrasing" or responding in ways which clarified, amended, recast or lent support to another's comments, a code which fit well much of the formal fishboning session. Interestingly, Leon's discussion of his two dumped boards brought only one instance of the category "defending" but several instances of "referencing team procedures," "referencing work rules," and "referencing company organizational structure," those moments where team members called attention to rules, procedures and organizational structure, whether for the purpose of reminding, chastising, correcting a problem or justifying an action. These turned out to be the most frequently used codes in the Wave Solder meeting. We found they fit Carlos in particular, but Dai and Leon as well, as throughout the meeting they either negotiated who would sit where and speak when, or discussed what engineers would or wouldn't allow, or described feedback processes and channels of communication. One of the most interesting categories was something we seldom coded and which, as it turned out, was applied only to people in or assuming positions of relative authority or (self-)importance, such as supervisors and (surprise?) researchers. The category was "bestowing blessings," that is, declaring, in some way that invokes the mantle of the traditional power structure, some work or team process good and worthy of the time spent. In the Wave Solder meeting, for instance, Mr. Po bestows his blessing on the team for their problem-solving process, and in so doing, he surfaces from a half hour of silence to re-assert the traditional hierarchy: He may be "only" the coach, as Carlos pointed out, with "no right to interfere," but he is nevertheless in a position to evaluate and grant praise (or not), just as he is in a position to admonish, another code which applied only to Mr. Po and Carlos.

What is helpful about this type of analysis is that it requires us be more precise about identifying the kinds of activities that actually comprised team meetings and the kinds that were absent. In general, we found that meetings, at their best, included some identification and analysis of problems on the floor. Sometimes this happened formally, with fishbone diagrams and such, as in the Wave Solder meeting, and sometimes it happened informally, as in the Acon meeting. However—and this is the rub—actions were rarely if ever taken by the teams regarding the problems they uncovered. In the worst and most common scenario, problems were identified and characterized, but were never mentioned again. Thus, the Acon team might complain about defective parts, they might explain the production practices that resulted in their reduced productivity, but they never did anything about the problems themselves. Documenting the reasons for their low productivity rate was as close as they came to taking action. More rarely, lead workers would promise to "look into" an issue, usually by consulting with a supervisor or an engineer or in this case a technician, leaving the other workers out of the loop and maintaining the traditional hierarchy.

Now, there are several possible explanations for this gap we witnessed so often between workers conceptualizing a problem and being able to take action on it. One could argue that teams simply didn't know how to take the next step, that they hadn't learned this crucial skill in the SDWT curriculum. One might conjecture that team members had no time to engage in problem-solving missions, so bound were they to production goals. One might find fault with the kinds of problems that workers identified, which tended to focus outside their own areas rather than within their own domains. We think the most robust explanation, however, has to do with the culture of the company itself and its apparent ambivalence about "empowering" workers and continuing to tightly control them, a tension we have already identified in the "Accepting Change" class. The identities that workers constructed, and it appears, the identities that were valued by the company for its workers despite its investment in self-directed work teams, foregrounded a willingness to follow instructions and to accept change without question, rather than to ask questions and problem-solve.

Once in a meeting of another team we witnessed a discussion among the team members, the team lead, and Lan the supervisor regarding a new manufacturing rule recently imposed by management. The gist of this rule was that whatever the job workers were carrying out, it should be done by at least two people on the line. The thinking was that two sets of hands are better than one, that two will get the work done faster than one. This rule may have worked fine in many situations, but led to ridiculous and counterproductive work practices in others. For example, sometimes this particular team, which specialized in mechanical insertion of larger parts onto boards, had small jobs to deal with; that is, the MPI would call for their area to attach only one or two parts or to put masking on one or two sections. In these situations it was more time-consuming to divide the work among two people than for one person to take total charge of it. But under the new rule, one person must put on a strip of tape, then hand the board to another person, who puts on another strip. During the team's discussion of this new work rule, there was much laughter and joking about its silliness and not a few complaints and worries. "They keep on changing the rules every day," noted one worker. "I don't want to contradict my manager," said the lead. However, there was no suggestion, no discussion whatsoever that management be apprised of the difficulty and advised to change the rule. This was not part of the culture of the factory, despite its organization into self-directed work teams. A few days after the team meeting I had a chance to ask the lead worker about the rule and why workers weren't authorized to determine when and when not to apply it. Mr. Marco, a retired dentist from the Philippines and a father figure to his younger team members, merely shrugged and said with some resignation, "Management decides." Workers should be able to decide how to arrange the equipment and the tools, he believed, because they know the most about them, but management decides. Of course there were exceptions, Leon not the least among them. He had decided that he would follow those rules which worked, ignoring those which made little or no sense according to his experience and careful judgment. But Leon was a rare breed. More often we found that workers in this environment, with its multiple constraints and contradictory pressures, believed "The better solution," as Juan put it, was to "just follow the profile."

Literacy practices were also implicated in this culture where management decides. We cited some instances above of workers taking charge of literacy, so to speak, not only acquiring the various practices valued at the company, but turning writing to their own purposes—creating a paper trail, to use the example above, documenting a reasonable explanation for their low productivity on a given day. We must point out, however, that for the most part, the kind of literacy valued in the factory emphasized self-monitoring, not self-direction, and that workers had no choice but to abide by rigid documentary rules—recall Xuan being resigned to the fact that, once entered into the computer, her team's productivity score couldn't be changed even if it were wrong. Leads spent inordinate amounts of time counting and figuring and tabulating, all in service of accountability. While on the one hand, self-directed work teams were supposed to be empowered to solve their own problems, on the other hand, managers and engineers appeared so compelled to measure and document quality and productivity, to find ways to quantify the teams' work, to keep tabs and to keep track—all through literacy-related activities, we might add—that workers were left very little room to maneuver.

One more literacy related example will make this point. We have already mentioned that manufacturing process instructions were the central documents on the shop floor. Written by engineers, there was a set of these instructions for each individual circuit board. They outlined the manufacturing process from beginning to end, for each department or area, and listed the type, amount, and serial number of each component to be affixed to the board. These central documents were consulted when engineers determined standard times, or how long it should take to complete a given piece of work on a board. And these standard times, of course, influenced productivity scores. It was well known on the factory floor that MPIs were often wrong or outdated. Busy engineers just didn't always have the time to make corrections, or they overlooked tiny details that nonetheless made the difference between a board that worked and one that failed, or achieving your productivity goal for the day or missing it. Despite the fact that they knew about the problems with the MPIs, workers were absolutely prohibited from changing them, from making an alteration even of the smallest kind. On one afternoon the researchers were watching Xuan as she studied one MPI. She eventually found the problem that she was looking for—the author had mistakenly written a "1" where an "11" should be in the column listing the number of components. This simple mistake had major implications for Xuan's line in terms of productivity calculations. It obviously takes eleven times longer to load eleven components than it takes to load one; the group's "standard time," or the amount of time allotted for assembling that board, was thus way off kilter, and so would be their productivity—if they went ahead and assembled the board as it should properly be done. One of the researchers reached over with a pencil and attempted to write in the other numeral, whereupon the usually docile Xuan gave a startled shriek and ordered us away, explaining that we must not, and the workers must not, nor even could Lan the supervisor modify an MPI. She and her group went ahead and did the boards correctly and suffered the consequences. Other workers took different approaches: A couple test operators found one engineer especially difficult to work with whenever they approached him about errors or omissions in his Test Process Instructions (TPIs), so they quit telling him and instead took to troubleshooting the TPIs themselves and working from the revisions they had penciled in their own notebooks. In other cases, workers refused to make changes they knew were needed when the MPI was incorrect, even if the engineer gave verbal permission to do so. "Don't go by verbal, go by written," Mr. Marco warned his group again and again, having been burnt once too often.

In some ways, then, the literacy practices of the factory—who is enabled to read and write which documents for what purposes on which occasions—are a window on the work practices of the factory as a whole and the hierarchical structures that governed them. Despite the fact that Teamco required its workforce to organize around teams, required those teams to meet, and required them to problem-solve and to continually find ways to improve and document their quality and productivity—despite the fact that it claimed to want a thinking workforce, a self-directed, and empowered one—we saw continual evidence that workers received a conflicting message, that they were in fact quite constrained in terms of the actions that could take, the decisions they could make, the influence they could have, and the literacies they could practice.

Opening on Broadway: Team-Related Presentations and Competitions

An important part in the team process at this factory was presentation to management, both at quarterly competitions held in each division of the factory and at monthly management meetings held at the company headquarters. If the quarterly competitions were equivalent to opening in Peoria, we were told, the monthly presentations were the corporate equal of big-time Broadway. In addition to these rather formal, fanfared performances before management, employees were also called upon to present data or respond to problems at cross-area meetings within the factory; these were usually attended by supervisors, engineers, leads, and sometimes front-line workers who because of their proficiency with English had been urged to attend by (and in place of) their leads. While many of the cross-area meetings that we attended did not appear to accomplish much—workers sat leaden-faced while supervisors or engineers talked long and technically—occasionally we witnessed gatherings that served an important function for workers.

One such moment occurred at a meeting of the "Goal Review Board." Made up of production workers and supervisors representing the plant's eight functional areas, this Board's initial purpose was, as its name suggests, to evaluate the appropriateness of the quarterly goals that teams were required to set for productivity and quality. But gradually the Board expanded its focus and began to serve as well as a forum where workers could be encouraged to learn about teamwork and the goal-setting process by being required to present various information to the group.

On the occasion we will describe here the board had asked team representatives to share their quarterly goals for productivity and quality, to present data showing progress toward those goals, and to explain how they measure that progress, how they calculate productivity and quality. Joanne Peterson, a quality engineer as well as the building's SDWT coordinator and facilitator of this meeting, had asked Mateo Bulosan, an industrial engineer, to start the meeting by explaining standard time—the time a particular process is expected to take—who sets it and for what purpose, how it used in calculating earned hours and actual hours, and how these hours in turn are used in calculating a team's daily productivity. As he spoke and wrote examples on the board, some of the workers pulled calculators out of their smock pockets and checked his calculations. Others jotted notes, read over forms, looked at the screen, then back at their notes, then conferred with each other. Some appeared to pay little or no attention to him and instead tried to finish the overheads for the presentations they would have to make later in the meeting.

Following Mateo's explanations and examples, Xheng Qian was called up as the first team representative to present. A high school geometry teacher in China for 14 years before immigrating to the United States in 1983, Xheng had been working for Teamco since 1986. She started in First Mechanical, screwing brackets to boards, snapping on components, sticking on bar code labels. Currently, she is the lead in the set-up area for the SMT (surface-mount technology) lines. She and her co-workers load "feeders" or reels with IC's or with tiny resistors and capacitors that will be fed into roboticized "pick-and-place" machines, machines which place components onto printed circuit boards. Though recently recommended for promotion to swing shift supervisor for the SMT area, Xheng turned down the offer, telling the supervisor who had recommended her, the fellow whom she would be replacing, that she didn't think her English was good enough. While she feels her English is fine for her current work, she's afraid that as supervisor she will have to speak with customers and doesn't feel confident enough for that. She did tell her former supervisor, however, that if he were to recommend her again when the next opportunity came up, she would be ready.

Standing at the front of the room and reading from the overheads she had prepared, Xheng summarized her team's data collection process and their quality and productivity calculations. She was aware that the company wanted teams to measure their quality in terms of parts per million (PPM)—that is, a weekly average of the number of defects or rejects per million units. In her area each loaded feeder is a unit, while in other areas each part placed on a board is a unit. Xheng knew that in an area such as Hand-Load, for instance, where workers place thousands of components on boards each day, the average number of defects per week might be only 50 PPM, significantly lower than in her area, where they load only a few hundred feeders each shift. She was concerned, then, that her area would look bad if forced to use PPM as a measure of quality. This concern was heightened by the new policy linking quarterly bonuses to the team's performance against their goal, and by the new practice of displaying printouts of quality and productivity charts on the wall by the time clock in the busy hallway between the manufacturing floor and the cafeteria. Before presenting her quality data, Xheng argued for a different measure for her area, preferring to record the percentage of feeders loaded without rejects:

Xheng: The quality, I think the self-feeder we cannot use the PPM. Ah, we use the percentage is better. Because ah, okay, example. [walks over to the dry erase board and picks up a felt pen] Every day the average four hundred feeder we set up. If one reject, if use PPM [pauses to write the following on the board]

$$\text{PPM: } 1/400 = X/1{,}000{,}000$$

$$X = 2500 \text{ PPM}$$

Xheng: Four hundred, four hundred feeder, one reject, we get a two thousand five hundred PPM. Very bad quality, right?

Joanne: Oh, but you don't have to worry about the number.

Xheng: [writes "%:" on the board and then continues] If use percent, that's better, I thinking. Okay. Ah, one reject, four hundred feeder, right? By hundred percent. [while talking, writes the following on the board]

$$\%: \quad (1 - 1/400) \times 100\% = 99.75\%$$

Xheng: We can get ninety-nine point seven five. Very good quality. [laughs] Right? Yeah. We use percent, better. Okay. That's what I think.

Joanne told Xheng that she need not worry about the specific number of defects, but that she and her teams should instead focus on the team's quality trend. Besides, she continued, Xheng's team doesn't have much choice since the company's database is set up to record PPM as the measure of quality. And again, because that is what the company database is set up to record and print out, that is what is displayed on the quality and productivity charts—which means her team's charts, tacked up in the busiest area in the plant, appear to show quality defects at a rate five times the average for the rest of the teams.

Joanne's suggestion to Xheng that "you don't have to worry about the number" would eventually prove a bit naive, for in a later meeting to review goals submitted for the new fiscal quarter, the manager of the SDWT effort would announce that teams with goals he had assessed as "low" would be required to revise them. And Xheng's goals, due to the difficulties described above, would definitely fall into the "low goal" group. To circumvent this problem, Xheng—with help from her supervisor and from Joanne—later devised some creative ways to enlarge her denominator a bit, thereby enabling her team to get its PPM goal down from 2500 to 500. The team's goal was submitted and approved. And when the time came for her team to submit its goals for the next quarter, Xheng again worked with her supervisor to write up an analysis explaining why the new goal was essentially the same as the previous quarter's goal.

Presentations such as Xheng's illustrate the importance of a public forum in which workers can articulate and legitimate problems and secure the resources to solve them. This was exactly the kind of space that Eduardo back at EMCO longed for and didn't have. They also illustrate the sophisticated nature of the problem solving that some Teamco workers engaged in as part of teamwork. Not only did Xheng have to perform basic math calculations, she had to analyze the social settings in which the calculations would be used. Workers needed to be able, then, not only to collect data and plug the numbers into formulae in order to calculate earned hours and actual hours and parts per million, but to know alternative formulae, to understand various uses of calculations, to understand how to present data orally and in writing and how to argue with numbers. Xheng further demonstrated the importance of being able to work with the simplified, standardized form and the system of measure required by the company, and still accurately and fairly represent a complex work process. The latter had gained particular importance since team bonuses were based on performance, and teams were expected to show "evidence of progress."

Presentations at cross-area meetings of groups such as the Goal Review Board were challenging activities for many workers at Teamco. For example, we recall how nerve-wracking the experience was for Xuan, lead of the Acon team, and how other leads rushed through their speeches, parroting whatever the person before had said just to get finished. But these practice presentations compared not at all to the grandeur of the main event, the formal presentations that took place before management. In these presentations workers were supposed to introduce a problem their team had solved and display the data to back it up and entertain questions from the audience. Each quarter teams from different buildings at the company would compete against each other for a monetary prize. And each month the best of the building teams would present before the highest levels of company management, including sometimes the CEO.

We watched many of these formal presentations as white-smocked workers stood in front of a room full of suits, their overheads of charts and graphs carefully prepared and in hand, their speeches rehearsed and often memorized. And we were very, very impressed. Here is the beginning of a speech by a Filipina, Ester Bonifacio, who was the quality assurance person in a Hand-Load line, and who had been with Teamco since its beginnings:

Ester: Good morning, everyone

People: (in chorus) Good morning

Ester: My name is Ester-Bonifacio, representing Building One, team seventeen. Before the technical stuff, I would like you to get a glimpse of us [brings hands to chest] as a team and the project we are working in..okay? [smiles]

People: (murmurs of agreement)

Ester: (pp) Yeah. (f) The self-directed working teams were formed three years ago under the direction or guidance by the- all the facilitators and the design team of building one. And from then on [forward arm gesture] these teams are- were working- are or were working hard in trying to improve the working process in productivity and in quality, of course. The- these teams, they meet every Mon- every Monday at two o'clock in the dining room. The supervisor or the design team are also in attendance [clears throat] and while [brings arms from side to front, hands clasped at chest level] each team have their own perspective time and place, our team- team seventeen meets at two o'clock on Tues- on Tuesday afternoon. And (high pitch) of course, (normal) there are some barriers in- (high) in our meeting. Right?

People: (scattered laughs)==

Ester: ==Because of the- the diversity of the cultures and then that's the communication it's in [moves hands from chest outward]. [shaking head] A lot of them could not..[smiling] or I won't say could not, they have a hard time in the English dialect. But everyone help each other, or they try to cope with the problem. Like me, I have most of them Vietnamese [smiles] and they really have a little bit har- hard time in speaking out [moves hands outward from chest]. But we kind of help them, urge them to speak up, even in sign language they can do (laughs slightly). So, that's the meeting we're having. And now we go to the- our project... I would like you to come with me [touches chest] in- [gestures hand upwards and out, in a large, sweeping motion to the right] in the-in the AMAT project and we go now to the loading area [brings hands down and turns body and hands to the left]. [Turns to face audience] Each operator is d- doing different assembly for a- yeah-different assembly. Why? Because Applied Material is a high mix, low volume project. Just imagine, we have more than three hundred (high pitch) fifty assemblies [smiles]...Okay? Three hundred fifty now going maybe four hundred because we have a lot proto-type lately. And then also we the same in second mechanical. They doi- it's wor- it's operator is doing a different assembly, like nineteen fifty-four, eleven o -two, nineteen eleven, [moving head back and forth] or (accelerated speech) o-one, or o-eleven- we have really a lot, [moves hand, pointing finger, from waist level outward and up] one through three hun- almost three hundred fifty [smiles]. And now [walking right, to other side of overhead] lets go to my area, over here. QA. I'm a QA myself [touches hands to chest]. In my mind [points finger to head] there's the computerized drawing of each assembly I'm working. I'm really an expert [smiles]. [smiles and nods] It's guaranteed. But=

People: =(Laughter)=

Ester: =It's guaranteed[gestures hands forward; chest pushed forward; smiling] yeah=

People: =(Laughter)=

Ester: =[Smiling, moving hands] It's like a piece of cake= I'm real proud of that. It's true.

Of the formal presentations we observed, this one by Ester was the most theatrical and even relaxed. Drawing no doubt on her experience with Toastmasters, Ester took pride in making her part of the presentation entertaining. Interjecting humor throughout, gesturing and making full use of body language, Ester even interacted with members of the audience, calling them by name and asking them rhetorical questions as she went along. In contrast to Ester, though, most workers were clearly nervous and ill at ease as they went through their prescribed paces on Broadway—identifying their teams, explaining their seven-step problem-solving process, displaying their data on quality and productivity, and fielding questions at the end—many of them coping valiantly with less than perfect English.

There was something wonderful to us about these meetings, these spaces where workers and managers came in touch, where front-line employees did the talking and explaining, where managers could ask but not direct. Perhaps as academics fond of and accustomed to such public displays of literate abilities, we romanticize these presentations a little too much. But still, the image was powerful to us, and we expect, would affect others similarly. It represented the meetings of groups in the corporate world who are normally divided from each other by vast social, economic, and cultural gulfs, and it reversed the power differential for at least a moment by at least a little. And it should lay the foundation for the formation of new work identities and new social practices.

What we found, however, when we looked more closely at these team competitions and presentations to management, was that old work identities and old social practices were nonetheless very much in place. Many teams were never asked or allowed to participate in these presentations, due to a complex system of requirements and eliminations. It turned out that the teams that could benefit the most from the discipline of preparation, such as Xuan's Hand-Load line, were the ones least likely to be chosen. Of those teams selected to present and compete, most team members had nothing to do with the process. Supervisors and team leaders tended to construct and choreograph the presentations, supplying the data and the charts and the script. While the presenters benefited at least from the experience of preparing and speaking to management, most workers remained aloof from the process. The whole affair began to take on, for us, the flavor of a dog and pony show.

But perhaps the deepest problem with the presentations was the added layer of competitions. In the quarterly divisional meetings, and in the company-wide year-end finale, teams competed against each other, were graded by a committee of managers, and were awarded monetary prizes. While the winners were happy on such occasions, the losers (which included Ester's team, by the way) were very bitter indeed, and often questioned the legitimacy of the scoring process. In one such competition, in which one team would be selected to represent the division at an upcoming company-wide competition, three teams lined up against each other. Of the three, one had worked long and hard to come up with new material, new problems solved, etc., while the other two used the identical presentations they had won with in the past. It turned out that the team that presented new material, and that in truth that embodied the best of what teams are supposed to be about, came in last, in part because their presentation style was less polished.

A conversation we had with a technician named Carlos, whom we met earlier in the section on team meetings, revealed the effect that such inequities have on workers' morale, and also reminds us one more time of what the team experience is like from a front-line worker's point of view. When we visited the factory the week after the competition, Carlos had canceled his group's team meeting (after which one member clapped and almost ran back to her station to tell the others). He pointed out that the group had been meeting regularly for almost nine months, that they were tired and needed a break. He also noted that other teams never met, yet they received their quarterly bonuses, which made his own group question whether meetings were really necessary. Carlos went on to express his dismay at the results of the competition, given that the other presenters had merely relied on old material. The conversation became more and more wide-ranging, as Carlos expressed his concern that many of the mid-level managers and supervisors in his division had not really embraced the team concept. This stance he found short-sighted, for he believed teams were there to stay. As he put it, "We have no choice but to accept the change" (a statement that would have made Gladis the instructor proud). Carlos dismissed managers as "bunches of uh, of bourgeois," who likewise dismissed workers as "people who just work on the floor." And finally, he reiterated his belief in the efficacy of teams, but insisted as well on a commitment from management: "Well, the idea of teamwork is, you know, very good, but ... management should give us the tools, the support, encouragement."

FINDINGS ONCE MORE: ANALYZING THE FUNCTIONS OF LITERATE ACTIVITIES

In the bulk of this report we have offered narratives in some detail—tales of two factories, if you will. Through them we have hoped to provide a detailed and nuanced sense of what work is like in circuit board assembly and the role of literacy in that work, as well as a feel for who the workers are. So much talk about "skills" is done acontextually these days, with scant reference to actual situations, particular workplaces, and real people. This way of talking about skills, as we will argue in more detail later on, misrepresents the nature of working knowledge and leaves us with pat, inaccurate skill lists and related curricula. So we hope that our narratives, which insistently locate what people are required to know and do as workers within the social, cultural, and political worlds of the factory, will serve as a corrective to the tendency to always speak generically of skills.

Our narratives have of course included evaluations, our interpretations of the meaning and significance of the stories. That is, by relying on various methodologies—inductive analyses of patterns of behavior, conversational analyses of spoken language, socio-cultural analyses of literate activities embedded in work—we have figured out what our qualitative data mean, and we have shaped the narratives to present those meanings. In so doing, findings from the project have emerged in broad sweeps. We have demonstrated, for example, that both the traditionally organized and the "high performance" factories are awash in literate activity. We have illustrated, further, the relationship between work organization on the one hand and work identities, literate activity, and workers' rights and responsibilities on the other. Thus, while both factories rely continually on literacy, one workplace clearly requires more literacy and different literacies than the other. Despite this contrast, however, we have also seen serious constraints on the exercise of literate abilities at the high performance factory as well as the more traditionally organized one.

In the following section we want to go beyond these broad characterizations and present our analyses of the literate requirements of work in finer detail. For example, instead of saying "different literacy is required," we want to explain exactly what we mean by "different," being as precise as we can through our definitions and illustrations. In this way we can lay bare our methods and open our procedures and our findings to closer scrutiny. But the process will also allow us to provide a more precise, more helpful level of detail to researchers and educators who are interested in the nature of literate activity in the workplace. Below we first offer an account of the particular analytic methods we developed and employed, an account that is finer-grained and more focused than that we provided at the beginning of the report. Then we present our findings.

Throughout we make ample use of appendices to illustrate our analysis in detail, and we refer as needed to the narratives from the previous sections to illustrate our categories.

As we explained in our methods section above, we used work events, team meetings, and training classes as our units of analysis. Audio and/or video tapes of these events, meetings, and classes were transcribed. Then we read the resulting transcripts and, working inductively, we coded them. Usually the member of the research team who had been responsible for collecting the data was also responsible for making a first pass at the codes. However, that person presented his or her codes to the entire research team for discussion, and in this manner, we were able to continually refine the categories as well as to ensure the reliability of our coding.

We coded the transcripts first according to the functions that reading and writing served. That is, we noted any use of or reference to reading and/or writing, and, drawing on our knowledge of the situation, the participants, and the activity, we determined the function that use served in that particular instance. Complete examples of our analysis of the Obsolete Documents work event and the Wave Solder team meeting appear in Appendies F—I. As we analyzed more and more transcripts, we added to and emended this emerging taxonomy of literate functions. At the end of our analysis, we had identified approximately eighty functions that literacy serves at EMCO and Teamco; these are listed in Appendix J.

Making sense of this analysis required one more step. Taking our list of eighty-odd literate functions, and again working inductively, we grouped together like categories. For instance, we put "copying" and "labeling" in the same list, and "creating hypotheticals" and "problem solving" together in a different one. When we were finished, we had created seven broad meta-categories of literate functions: Performing Basic Literate Functions, Using Literacy to Explain, Taking Part in Discourse Around & About Texts and Literate Activities, Participating in the Flow of Information, Problem-Solving, Exercising Critical Judgment, and Using Literacy to Exercise or Resist Authority. The meta-categories and their members appear in Appendix K.

Then, it was a simple matter to return to our analyses of work events, training classes, and team meetings, and re-present these according to the meta-categories. The resulting worksheets (see Appendices L—O for examples) allow one to see, almost at a glance, which participants in which situations use literacy in which ways and with what frequency.

In addition to analyzing the functions that literacy served in team meetings, work events, and training sessions, we developed two additional coding schemes, one centering on team meeting activities and a second centering on classroom activities. Although the primary focus of our project is literacy and its relationship to changing work, when we began to analyze team meetings, we realized that we were ignoring a wide and significant range of activity that was not literacy-related but that merited attention. Similarly, when we began to analyze training sessions, we became aware of certain types of activities that seemed unique to classrooms—that didn't occur elsewhere in the factory and that weren't represented in either the literacy or team taxonomy.

Our team taxonomy is every bit as elaborate as our literacy taxonomy, and we include it in Appendix P. And we include the classroom taxonomy, which is brief in comparison, in Appendix Q. The classroom taxonomy is brief, because in analyzing classroom activities, we first applied our literacy and team coding schemes; then we developed classroom codes for activities that seemed peculiar to the training room. In the future we expect to develop meta-categories for the team taxonomy and to proceed with the same kinds of analysis that we will illustrate here with the literacy taxonomy. This part of our work is still in progress, however, and our discussion of it in this report is limited. We do think the team analysis has great potential to reveal—on a grander scale than our looks at literacy—workers' roles, responsibilities, and constraints in changing work environments. Suffice it to say here, by way of introduction to the taxonomy, that it illustrates an interesting range of actions, stances, and identities.

Before going on to discuss what the literacy analysis has allowed us to see, we need to provide one important caveat on using the taxonomy. The meta-categories represent robust tendencies rather than hard and fast rules. That is, depending on the context, any literate function, while usually being an example of one particular meta-category, might fit better into another. Thus, the meta-categories suggest primary allegiances, but less frequently any function can be used in a variety of ways. Further, almost any function might fit into the last meta-category—that is, *Using Literacy to Exercise, Acknowledge or Resist Authority*—again depending on context. One warning, then, is that the meta-categories should not be used as just another set of skill lists, but rather an a heuristic for analyzing and understanding literate activity.

A second caution has to do with our ordering of the meta-categories into a continuum, beginning with *Performing Basic Literate Functions* and ending with *Using Literacy to Exercise, Acknowledge or Resist Authority*. The *Performing Basic Literate Functions* meta-category includes uses of literacy such as "copying," "keyboarding," "proofreading," and "labeling." The final meta-category includes literate functions such as "gaining consensus," "gauging reactions," and "requesting action." Now, one of our greatest worries in offering the meta-categories in a particular order is that they will be read as representing a kind of developmental progression. That is, some educators, researchers, or lay people might infer that first workers (or students) need to master the *Basic Literate Functions*, and then they can progress to the second category of *Using Literacy to Explain*, and finally they'll be sophisticated enough to engage in those functions in the last meta-category having to do with exercising, acknowledging, or resisting authority. Nothing could be further from what we found in our field research, or how we intend the taxonomies to be used. It is true that the meta-categories are ordered according to a progression, but this progression has to do with rights and opportunities for exercising literate abilities. As we will illustrate in the following section, we have seen both workers and managers engaging in literate activities from all seven meta-categories. However, the categories on the left-hand side of the chart—*Performing Basic Literate Functions* and *Using Literacy to Explain*—are most often the categories associated with and available to front-line workers. The categories on the right-hand side of the chart—*Exercising Critical Judgment* and *Using Literacy to Exercise, Acknowledge or Resist Authority*—are most often the categories associated with and available to those in positions of authority, such as supervisors, managers and engineers. In other words, our meta-category chart and the continuum it represents demonstrate how patterns of literacy use are generally linked to structures of authority. This point will become clearer in the following sections as we illustrate our research findings with regard to literacy.

Literacy Finding One: Much Ado about Literacy

In recent years there has been much ado about increasing skill requirements in the workplace, literacy included and literacy in particular. We think that this assessment, at least in its broad outlines and general direction, is accurate. There can be no doubt about it—both EMCO and Teamco were awash with literacy. Or to mix metaphors, literacy provided the frame, the scaffolding, the superstructure within which work got done at these circuit board assembly plants. Our evidence for this claim is the eighty-odd functions that we saw reading and writing serve on the factory floors, in meetings, and during training sessions. This number suggests something of the remarkable diversity of the literate activities in these workplaces. But we can give a richer sense of this range by turning to a few examples which highlight some of the functions and also the seven meta-categories into which we grouped them.

The first narrative that we provided early in this report was from EMCO, the traditionally organized factory, and reported a "re-work event," in which workers had to set in motion an engineering change, a modification in how a particular board was assembled. Readers will recall that this event began with Maggie the supervisor looking through the documentation on the engineering change, bantering all the while with Leonard, the engineer, and that it ended with leads Eduardo and Hee-Fon reorganizing the work flow and with line workers Lee and Thuy doing the job. In this work event we see instances of each of the literacy meta-categories—from *Performing Basic Literate Functions* to *Using Literacy to Exercise, Acknowledge or Resist Authority*. In the excerpt below, for example, Hee-Fon and Leonard function in the meta-categories of *Exercising Critical Judgment, Participating in the Flow of Information,* and finally *Using Literacy to Exercise, Acknowledge or Resist Authority*. First, we see Hee-Fon and Leonard looking over and *evaluating* a sample board she just made according to Leonard's instructions and based on his sample board. Next we see Leonard *giving instructions* about the next step in the re-work, Hee-Fon *disputing* those instructions, and Leonard *deferring*. Finally, we see Hee-Fon *requesting approval* from Leonard on one aspect of the representation she has constructed, wanting to make sure that he will still approve of it when he sees it the next day or if it might become the subject of official sanctions.

Hee-Fon: It's good, huh? [compares her wire route to that of the original sample] Lot better?

Leonard: Looks good. [examines board. only step remaining is cutting the trace. Leonard still plans to use an Exacto] Maybe it'd be easier if we cut it right next to here and just flipped it back, see?

Hee-Fon: Mhmm.

Leonard: You know, rather than trying to cut it...if we, if we just took.. cut it right next to the, to the, uh, thingy, if you could get it right next to it and then peel it up and then clip it off. I don't care how you cut it. Cut it any place you want to, what do I care?

Hee-Fon: No, no, no. Yeah, I think it is better, right?

Leonard: Do whatever you want to.

Hee-Fon: [demonstrating the steps she wants to take for soldering the ground strap then gluing the shield. The next couple lines represent a best-guess transcription] (Maybe I make-ee this one, make-ee over here? Then we glue. How it make-ee test, or no. 'Haps, they may say something? But more is the better, I think.)

Leonard: Do it any way you want.

Hee-Fon: Uh huh. (laughs) OK. OK. Something ask you. This a lotta solder. Is no way?

Leonard: 'S all right.

Hee-Fon: Is OK?

Leonard: Sure.

Hee-Fon: Doesn't matter?

Leonard: I don't care.

Hee-Fon: You don't care?

Leonard: Looks beautiful.

Hee-Fon: Yeah, looks fine tomorrow, right?

Leonard: Yeah.

Let us return, next, to the Obsolete Documents event, which also took place at EMCO. This event, readers may recall, involved the lead worker, Eduardo, and his struggles to correct an obsolete document. In this event we again see instances of each of the literacy meta-categories—from *Performing Basic Literate Functions* to *Using Literacy to Exercise Acknowledge or Resist Authority*. Especially notable are the high number of instances in the meta-category_*Taking Part in Discourse Around and about Text* and in *Exercising Critical Judgment*. Many of the instances of the latter involve Maggie, the supervisor, and Eduardo *interpreting* the engineer's documents, *evaluating* proposed solutions, *gauging possible reactions* to those proposals, and then *critiquing* the engineer's obsolete documents. In the following example, Maggie and Eduardo have been working at the problem for some two hundred lines of transcript. They have been through all the documentation and have brainstormed a number of possible solutions. Here Maggie is *perusing* the MPI, re-reading parts aloud, while Eduardo is *contextualizing* the activity, providing background on the various shifts' work on the board. Next they look at the assembly drawing again, *critiquing* it and then *referencing* the MPI to discover the last time the documents were up-dated.

Maggie: Uh huh. [reading from MPI] "Install Q six, seven, twelve, and thirteen with mounting hardware after solder flow." After solder flow... [.06] hmmm. "See detail A. Add CR one after solder flow."

Eduardo: I guess the last time we di- day shift did this one-

Maggie: Oh, okay.

Eduardo: day shift did this one

Maggie: After solder flow. Mm hmm.

Eduardo: they put on this one and then they just put the hardware on these two. See, but that's the deficiency, they've been putting on the different part, and see this one, now no detail of this one should be cut in the middle, this one should be bent like this. That's what I'm saying. "Just follow the drawing," but this much different.

Maggie: Yeah, the draw- the drawing is definitely wrong. And how old is this MPI? [Reading a date on the MPI] "Four twenty-six ninety-four update BOM." This is eight thirteen when they initially released this to manufacturing.

Eduardo: The drawing says nineteen seventy-nine.

Maggie: [laughs] Bingo! See, this, ...

Now let's review a few team meetings from Teamco. The first meeting we presented above was that of Acon, a hand-load team. Readers may remember us characterizing the meeting as kitchen-table talk among a group of women. Acon team members showed little awareness of (or perhaps it was interest in) the expected conventions for running a meeting. But even at this quite informal gathering of workers from the lowest prestige and, some would say, lowest skilled area of the plant, we saw some forty-four instances of literacy representing functions from four of the seven meta-categories—*Performing Basic Literate Functions*, *Taking Part in Discourse Around and About Text*, *Exercising Critical Judgment*, and *Using Literacy to Exercise, Acknowledge or Resist Authority*. The most frequently used category was *Taking Part in Discourse Around and About Text*, as the lead, Xuan, and the unofficial team spokesperson, Eva, repeatedly *referenced* documents they had on hand or *cited* documents such as quality reports that played an important role in their work. Particularly noteworthy was their discussion of the necessity of documenting problems on the line so as to protect and defend their productivity scores. We reprint an excerpt of this discussion below:

Eva: Then you have to make a note at the back and tell tell them the reason why is our productivity is so low that day. So they will give us credit for that==

Xuan: ==I know, yeah, this time I forgot.

Eva: Ay-yai-yai!

[much laughter all around]

Eva: Did you see every time, did you see every time we have a meeting or something else I put a note on my paper?

Xuan: Yeah==

Eva: ==Yeah you have to do that all the time.

(17 related turns omitted)

Xuan: I write a note already.

Researcher: Good.

Xuan: But that ~~Acuson I forget~~ [laugh].

Researcher: [laugh] You forgot the Acuson.

[Much laughter]

Researcher: Okay [pause].

Eva: You'll remember the bonus.

[Much laughter]

Eva: [teasingly] Maybe we don't receive any.

[Much laughter]

In this excerpt Eva *invokes* a rule about record-keeping and at the same time *admonishes* Xuan to do better job of this literate responsibility. She also raises the specter of the team's possible failure to meet productivity and quality goals and the related failure to get a bonus—all because the team leader hadn't made the required written accounting of the circumstances surrounding the team's low scores. These are examples *par excellence* of a sophisticated understanding and use of *Literacy to Exercise, Acknowledge or Resist Authority*.

The second meeting of the trilogy that we narrated above involved the Final Mechanical/Final QA team. In this meeting there was a wide range of literate activities performed by various members of the team. Two of three meeting facilitators—one of whom acted as an unofficial lead, and one of whom was a roving health and safety inspector—used the broadest range of literate functions, each of them spanning all seven meta-categories. The third meeting facilitator performed literate functions which fell into four of the seven categories. The most heavily used category in the meeting was *Taking Part in Discourse Around and About Text*, with a total of sixteen people doing a variety of things including *perusing* documents in hand, such as meeting minutes and agendas. All three meeting facilitators performed several functions in the *Taking Part in Discourse*

Around and About Texts category; for example, the roving inspector *presented* several reports to the team and *referenced* them as she spoke, and she also *reported* on a discussion she had participated in during a meeting with other workers in the factory, *citing* relevant work documents to team members during the course of the team meeting discussion.

Other team members' literate activities fell within this same category as well as two others—*Participating in the Flow of Information* and *Exercising Critical Judgment*. At one point there was a discussion of a new system for tracking circuit boards that needed to be re-worked. Due to the lack of clarity among team members about how to implement the process, an extended exchange ensued among the roving inspector, who brought up the change, and several of the production line workers. In her efforts to explain, the inspector spent much time *providing clarification* and *giving instruction*, while various team members were *seeking clarification*, *seeking direction*, and *seeking instruction* —all functions within the *Participating in the Flow of Information* category. During this same conversation several members of the team also *created hypothetical* work scenarios, a *Problem Solving* function, in order to help explain the new process to others.

Following the topic of rejects the team discussed drafting their goals for the upcoming quarter. This discussion involved an exchange about how the team counts defects—an important point given that this affects their ability to earn bonuses based on meeting team goals. Here again the meta-category *Participating in the Flow of Information* figured prominently; however, so did *Problem Solving*. For example, one of the acting leads *provides clarification* and *gives instruction* about how to count defects. She also performs functions in the *Problem Solving* category such as *planning* and *justifying* a course of action, *conjecturing* about what might happen to the appearance of the team's graphs if they change the way they are counting defects, and she also *creates hypothetical* work scenarios in order to help other team members understand what she is trying to explain.

In summary, then, we saw much evidence at both EMCO and Teamco—at traditionally organized and high performance factories—to suggest that literate activities are woven throughout the work of today's circuit board assembly. Now let us turn to the patterns of literacy use that distinguish one factory from the other.

Literacy Finding Two: The High Performance Hoopla

The popular discourse on high performance versus traditionally organized factories has generally assumed that high performance work requires more skills and different skills. In terms of literacy and ~~in~~ broad strokes, we have found this to be the case. Despite that fact that we saw instances of literacy from all of the meta-categories at EMCO, our traditionally organized factory, we saw striking differences as well. In essence, literacy use at EMCO among front-line workers was restricted according to position; leads got to exercise literate abilities, but work was organized such that the masses of front-line workers did not. Further, at EMCO literate functions on the right side of our continuum—*Using Literacy to Exercise, Acknowledge or Resist Authority, Exercising Critical Judgment*, and *Solving Problems*—were much more likely to be performed by supervisors or managers or people in traditional positions of authority. At Teamco, on the other hand, a wider range of workers were called upon to exercise a wider range literate abilities across the continuum. In particular, we saw more instances of front-line workers performing literate functions associated with the right side of our continuum, the power side. This occurred mainly through the opportunities and intellectual space provided in team meetings.

To illustrate these points in detail, let us return to the events discussed above, first the Obsolete Documents event from EMCO. In this event we saw instances of each of the literacy meta-categories—from *Performing Basic Literate Functions* to *Using Literacy to Exercise, Acknowledge or Resist Authority*. However, it is noteworthy that the only front-line worker who participated in this event was Eduardo, the lead. Further, the only instances of his *Using Literacy to Exercise, Acknowledge or Resist Authority* were when he acknowledged power—by requesting permission of the program administrator, Rod. Rod, on the other hand, functioned in this last category by virtue of his *granting permission* and by *protecting* himself by signing out boards to other people. Clearly, Eduardo perceived the literate functions that were available to him as having definite boundaries—and he was correct.

In the re-work event at EMCO, the literate functions were distributed across the meta-categories more evenly than in other events, with front-line workers Li, Thuy, and Lee *Taking Part in Discourse Around and About Text* and *Participating in the Flow of Information*, at least minimally, and leads Eduardo and Hee-Fon engaging in all the categories on the right-hand side of our continuum. However, this more even distribution of opportunity had little to do with how work was organized. Here, what flattened out the hierarchy was the person at the top of it and his willingness to create the space for the leads to *Exercise Critical Judgment* in their dealings with him. Leonard the engineer not only made himself available to the leads—rare among the engineers, Eduardo and Maggie the supervisor noted, especially when it involved swing shift—but he also let them know he was open to their suggestions and opinions.

However, while it is significant that the leads in the re-work event at EMCO were able to function across a range of literate purposes, what is also significant in the re-work event was the virtual absence of line workers across the categories. The full event centered around the supervisor, an engineer and the two leads and included the front-line workers only peripherally, and then after all decisions had been made. As leads, Hee-Fon and Eduardo *Use Literacy to Exercise Authority* as a regular course of their positions within the plant: They tell others what to do and how to do it. Occasionally, though, there is a case such as Hee-Fon's *request for approval* from Leonard. The front-line workers, on the other hand, carry out the work, but they are only minimally involved in the literate activities, and then only to *receive instruction* and *ask for clarification*.

Let us consider next the contrast between the literate functions practiced by a mid-level manager and those practiced by leads and materials handlers during the Movement Log training session which also took place at EMCO. Note that the front-line workers involved in the training session are the workers who are designated as responsible for engaging in literate tasks. We found the manager performing literate functions in each of our literacy meta-categories; however, the workers did not perform any functions in the last two meta-categories: *Exercising Critical Judgment* or *Using Literacy to Exercise, Acknowledge or Resist Authority*.

Both the workers and the manager performed *Basic Literacy* tasks such as *recording* data and *translating* information from one format to another. As was expected from a training session on a literate process, much of the manager's talk we categorized as either *Using Literacy to Explain* and *Taking Part in Discourse Around and About Text*. This involved the manager *explaining, elaborating , presenting*, and *dramatizing* to explicate the text of the revised procedure being reviewed in the training session. For example, here Mark H., the manager, explains the procedure, *elaborating, dramatizing,* and *referencing* the procedure, at the same time he is *citing* the literate process of completing a Movement Log form:

> Now, it says, if any portion of the movement log is incorrect, the issuing department material handler ~~must~~ adjust movement log and initial the correction. In other words, you said there were two hundred on there? But Chin counted it, and said, no, there's only one ninety-nine. You're gonna go, no, there's two hundred. I counted them. You know. But Chin's goin' no, one ninety-nine. So you've got to verify the re-count to make sure that there really is only one ninety-nine. Or, there's two hundred, he's still there, and you can go, hey, you don't know what you're talkin' about. Come here, you count it again. Okay? But you guys both have to agree on the counts. Who ever's givin' it to you, and who ever's gettin' it, you both gotta agree on the counts. So you gotta both be there when it's being verified. You don't just fill it out, drop it off, and walk away, and get back with ya' later. No. You gotta do it right then and there. Okay?

The workers' talk was categorized principally as *Taking Part in Discourse Around and About Text, Participating in Flow of Information* and *Problem Solving*. For example, here Mark H. asks the workers to tell him the problems they have with completing the Movement Log forms accurately at the end of a shift:

Mark H.: Now I want you guys to tell me what your problems are. Okay. Rudy, you said you have a problem that ends with shift. Everybody has- everybody tries to rush-rush==

Rudy: ==Yeah.

Mark H.: We got any other problems?

Rudy: Number one problem we have is with the- it's a lot of boards ( ) And then, with the boards that come at the end of the shift, we don't have time to fill out the ( )

Mark H.: Okay. How long would it take to get these boards done? Let's say if we stopped mov- if we stopped all movements as of fifteen minutes to==

U: ==Two forty-five

Mark H.: Two forty-five?

N: Yeah, two forty-five.

Mark H.: That gives us enough time to get it all consolidated and counted uh, movement logs made up, gettin' the other department to come over and double-check it. That fifteen minutes there, that's enough time?

Rudy: Yeah. I think so.

Mark H. *requests clarification* on Rudy's earlier suggestion that moving the boards at the end of the shift is a problem. Rudy and Diana (another lead worker) *provide clarification* in response to Mark H.'s request. Together, they engage in *Problem Solving* about this literate process all the while, *citing* the literate process of completing the Movement Logs accurately at the end of the shift.

As stated earlier, where Mark H. differs from the front-line workers is in his use of types of literacy we have categorized *Exercising Critical Judgment* and *Using Literacy to Exercise, Acknowledge or Resist Authority*. When reviewing the written procedure for completing Movement Log forms, Mark H. engaged in *highlighting, assessing, interpreting,* and *evaluating*. For example, here Mark H. explains where to reference the assembly number that workers need to write on the Movement Log form:

> And you want it to be the exact same part number as what you see on the WIP report. Okay? This is your guide, if you're not sure what it is. It should, number one, be in your MPI, what you're moving. You should know what you're building. But if you're not sure, this is a good cross-reference. This has all the part numbers of what we're currently building. The only time that a part number might not be on here is when Mr. Chin gets a brand new board for the very first time, in staging. Outside of that, I can't think of any other instance where a part number would not be on this report. So if you're ever in doubt as to what the part number is, look in the report. This tells you exactly how to spell it out. Because in some cases, your MPIs might have a dash in the part number. But our computer doesn't. So you don't want to mark it with a dash, for instance. Okay.

Mark H. is *highlighting* a certain part of the written procedure the workers are reviewing. He is *interpreting* the procedure by demonstrating that he understands the purpose of completing the Movement Log forms in relation to the company's overall goals and processes. Further, he is *assessing* the workers' understanding of this literate process, emphasizing that they "should know what they are building" by accessing other written documents, either the MPI (Manufacturing Process Instructions) or the WIP (Work in Process) report.

Before the end of the training session, Mark H. uses *Literacy to Exercise Authority* by *admonishing* workers—albeit with tongue in cheek—that with two of them having to complete and sign each movement form, they should do so accurately:

> Okay. Because I got two people signing that piece of paper: One that issued it and one that received it. You've both got to be right. And both, at least one of them is gotta know how to do it correctly. One of them has got to know how to count. One of them has gotta know how to do the part number. And odds are we should be able to get it correct with two people doing it. Right. Okay.

The WIP training session, then, was consistent with the other EMCO events we analyzed in that the *Exercising Critical Judgment* and *Using Literacy to Exercise, Acknowledge or Resist Authority* categories of literate functions were largely the province of managers, supervisors and engineers.

Now let's turn back again to Teamco. We've already seen instances of a wide range of literacy activities during the meeting of the Final Mechanical/Final QA team and even in the meeting of the Acon group. Let's focus in some detail here on the Wave Solder team meeting in order to demonstrate the ways in which team meetings could and sometimes did provide a space of greater opportunity for participation in this wider range of activities, serving a wider range of purposes. As we review this meeting and consider the opportunities for participation it presents, keep in mind the EMCO work events—Re-Work and Obsolete Documents—and the virtual absence of front-line workers in those events and their discussions about or decisions on work processes.

The Wave Solder team's meeting can be broken roughly into seven sections, according to broad activities or topics of discussion. Rather than reprint here lengthy excerpts from the transcript of the meeting, some of which were shared earlier in the paper, we will refer you to particular sections of the full transcript and a complete analysis of the meeting, which can be found in Appendix F. The meeting's first section (transcript lines 1-73) is an array of opening procedures: getting settled, taking attendance, reviewing minutes and inventing an agenda. We see Carlos, Dai and Leon *Taking Part in Discourse Around and About Text* as they*reference* minutes of the previous meeting and *cite* particular forms of representation (including assemblies and quality and productivity reports) as well as particular literate activities (the filling out of maintenance logs and the reporting on quality and productivity). Dai, in an example of *Exercising Critical Judgment, bestowed blessings* upon the team for its stable productivity. In a brief but *ironic* response to Dai's blessings, Leon appropriated the official language of the plant for what was both self-effacing humor and a critique of the company's expectations as represented in recorded standard times and measures of productivity (lines 54-56). This ironic note functioned within the *Using Literacy to Acknowledge Authority* category. Carlos also operates within the *Using Literacy to Exercise Authority* category, *invoking a rule or script* about how a meeting should be organized around particular texts—minutes and an agenda (lines 19, 48).

In the next section of the meeting (lines 74-116), Leon initiated a discussion of a problem he encountered on the line. Dai responded to the problem by *invoking a work rule*—an instance of *Using Literacy to Exercise and Acknowledge Authority* —a rule Dai *admonished* Leon to follow (lines 91-97). Leon's response was to *request clarification* on the rule, a way of his *Participating in the Flow of Information*. Leon attempted to *clarify* and *justify* his position and his actions to Dai. Both *Used Literacy to Explain* their concerns and actions regarding the problem and *Took Part in Discourse Around and About Text* by *citing* assemblies and profiles and procedures, comparing them to actual work processes.

Up to this point, the meeting had been dominated by Dai, Leon and Carlos. In the next sections, however, an invitation into the discussion—that is, into both the team's immediate discussion and the larger on-going discussion within the workplace—was explicitly extended to all of the team members when Carlos first brought to their attention the issues raised in the weekly quality meeting. The team members took up his invitation, especially when Carlos *proposed* and facilitated the construction of a fishbone diagram of one problem. Carlos exercised the authority he had as technician and team patriarch by first *proposing* the brainstorming and diagramming, and then facilitating it even after the team leader ignored the idea. His help we coded as *coaching*, or facilitating a literate activity or the understanding of a representation, a function of the meta-category *Participating in the Flow of Information.*

When Carlos raised the quality issue (lines 116-196), the concern about solder balls, Yiheng joined the conversation for the first time this meeting, *perusing* and *citing* the quality report, *signifying* his familiarity with the assembly referred to in the report, and *conjecturing* about the possible causes of the problem. Leon and Dai likewise *Took Part in Discourse Around and About the Text* (in this case, the quality report) and joined in the *Problem Solving* effort, adding to the flurry of *conjecture* about causes. Hoang also entered the conversation, *requesting* and *perusing* the report. And it was during this section of the meeting that Leon, always active in team discussions, began participating in new ways by *providing linguistic assistance* for Yiheng. Though this assistance was more obvious in later sections of the meeting, it began here with his *miming* particular processes as a way of helping Yiheng stay afloat in the conversation.

The range of participation in the meeting increased during the formal brainstorming session (the fishbone diagram) and the subsequent listing of solutions to the brainstormed (or fishboned) causes of the solder ball problem (lines 197-312). For the most part, over the course of the meeting the team members' participation fell into the meta-category *Taking Part in Discourse Around and About Text*. As with the other meetings and events we analyzed, this was the most frequently used category—a full two-thirds of the more than 150 instances of literate activity in this meeting represented functions in this category, with team members repeatedly *perusing* and *referencing* the documents on hand and *citing* assemblies, their profiles and machine settings and adjustments. But in this section of the meeting, with the introduction of the formalized process, the *perusals*, the *references*, the *citations* took on a different weight, a different function. As part of the brainstorming, the team members helped to shape the lists and diagrams as they referenced them, and then let these new representations shape their understanding of a work process. And so perhaps more significant than the several instances of *Taking Part in Discourse Around and About Text* were these fewer instances of *Problem Solving*: Specifically, six of the nine team members present participated to some degree in *brainstorming*, collaboratively constructing a representation for heuristic purposes. The brainstorming session was a swirl of literate activity, with workers constructing representations, clarifying proper categories for ideas offered, referencing items on the list, citing a variety of representations and literate activities, and all this within the framework of a particular work process in which they variously participate.

As the meeting wound down (lines 313-376), Dai *Took Part in Discourse Around and About Text* and then *Used Literacy to Exercise, Acknowledge or Resist Authority*, first *referencing* the list on the board and then *gaining consensus* from the team on those listed solutions. Carlos suggested to Dai that "Mr. Po have to talk" before the end of the meeting, an example of ***referencing team procedures*** as well as ***referencing the company's organizational structure***, both of which are team codes, though not literacy codes. Mr. Po put his stamp of approval on the proceedings, *bestowing blessings* on the team for their problem-solving process (a literate activity), *highlighting* one of the listed solutions. In highlighting it he was *citing* a representation (the profile) which was not on hand (lines 343-347). Leon asked Dai what would be on the agenda next week, thereby *invoking* an organizational rule (there would be a meeting next week) and a particular meeting script (there would be an agenda next week, and it would have been thought about in advance, and team members could and would call for a preview at the end of a meeting). Leon's invocation of an agenda—which in this team's meetings was (or was supposed to be) a written document on an official form, kept in an official binder—this invocation was an example of his *Using Literacy to Acknowledge Authority*, in this case, the authority of Dai to set the agenda. In an *Exercise of Critical Judgment*, Yiheng made a brief but poignant joking comment, drawing on his understanding of the endless string of quality reports and their habit of turning up at their meetings as agenda items (line 350). Dai, who had been *Performing the Basic Literate Function* of *recording* the minutes of the meeting, responded to Leon by *citing* the quality report and the weekly quality meeting, both the document and the literate activity in which it is presented and discussed. This impromptu *planning* of the next week's agenda fit in the meta-category of *Problem Solving*. Mr. Po then re-entered the conversation (lines 357-362), *Taking Part in the Discourse Around and About Text* by *citing* the up-coming ISO audit, a literate activity of the first order. Carlos joined him in warning the team to follow all the rules, all of which have been written down, in accordance with the ISO standards. In so *admonishing* then, Carlos and Mr. Po were *Using Literacy to Exercise Authority*—their own—as well as to *Acknowledge Authority*—that of the written instructions and of the team who monitors them.

This final section of the meeting does temper a bit of the optimism we might have felt watching the workers participate in the brainstorming process: The supervisor re-entered the picture, asserting his authority by bestowing blessings, admonishing the workers to follow the rules, and highlighting particular work processes and particular solutions, thereby leaving in shadow other portions of the problem and their solutions. Nevertheless, we can't ignore that the workers in this meeting were offered an opportunity to participate as a group in troubleshooting the work processes they are a part of while the front-line workers in the EMCO events were kept out of discussions of work processes and at a distance from texts. It is interesting to note that although the meeting was dominated by the lead, the technician and the senior operator, when the rest of the workers did participate, they were not only *Taking Part in Discourse Around and About Text*, not simply receiving instructions or requesting clarification, but with the help of a skillful facilitator such as Carlos, they were participating to some degree in *Problem Solving* and in further understanding the larger work processes their particular tasks are a part of.

On the basis of this literacy analysis we would argue that, while literacy was everywhere at both factories, at Teamco more literate activities were expected of a wider range of workers. At EMCO the leads were the only front-line workers with any responsibilities for literate activity, while at Teamco, virtually all workers were expected to develop literate sensibilities, and a rather impressive range of workers read and wrote and talked about texts for a rather impressive range of purposes.

Literacy Finding Three: Caveats and Qualifications Regarding Literacy Rights and Responsibilities

The public discourse about high performance work environments rarely ventures beyond blanket pronouncements on the benefits to be gained from self-directed work teams and the "learning organization" or uncritical praise for particular factories who've chosen this route. In our research, though, we've been privileged to look deeply at the implementation of teams at a highly regarded company, and in so doing to probe beyond the company's public persona and to document problems and challenges as well as successes. In essence, what we have found in terms of literacy practices at Teamco is that this company, despite its high performance ideals, actually placed considerable constraints on the exercise of literate abilities—because it placed serious constraints on workers' rights and responsibilities in general. While claiming to empower its front-line workers, Teamco generally continued to maintain traditional roles and relationships between workers and management, and this established hierarchy shaped and constrained literacy practices.

One of the places that traditional roles were most apparent was the training room, where workers went to learn how to participate in self-directed work teams. Readers will recall our analysis of the "Accepting Change" class, in which the instructor, Gladis, led workers through a curriculum that urged them to accept change at as inevitable and inevitably positive. We have already discussed the ways in which the content of this curriculum seemed wrongheaded or lacking, as it pushed workers towards unquestioning acceptance rather than inviting them to think critically about change. Here we can be a little more precise about the limited literacy practices that supported the message of the curriculum. While Gladis engaged in activities in which literate functions spanned all of the meta-categories, students in the class were severely constrained in their literate activities. They recited, they received instruction, they recounted, they completed forms, they did a bit of minimal explaining around literate tasks. But in a class designed to induct them into self-directed work teams, they engaged in virtually no activities which required literate *Problem Solving* or which required them to *Exercise Critical Judgment.* We would have thought the training classes, where workers escaped momentarily from time pressures and from what one manager called the brutality of the factory floor, would have been the prime place for modeling, practicing, and trying on the new activities expected of team members, including those leading to an identification with factory literacy, with numbers, forms, reporting, and the written word. But this was not the case.

In the team presentations that we have analyzed, where front-line workers stood before management and recited information on the data that they had collected and analyzed, we expected to see a great deal of literate activity that we could categorize as *Problem Solving* or *Exercising Critical Judgment.* But here, too, workers seemed fairly limited. Predominantly in these sessions, presenters used *Literacy to Explain* and to *Take Part in Discourse Around and About Text.* Perhaps because these sessions were viewed early on as performances, rather than as genuine dialogues between workers and management, there was small expectation and little incentive for workers to exercise those literate abilities associated with the right-hand side of our meta-category continuum.

Concluding Thoughts and Strong Opinions

Previous studies of literacy at work—even qualitatively oriented ones—have been content with broad brush strokes in terms of characterizing literate activities. Perhaps the most widely quoted examination of literacy at work—Diehl and Mikulecky, 1980—categorized literate activity as either "reading to know" or "reading to do." These authors claimed that "reading to do" characterizes literate activity in the workplace, while reading to know is what children do mostly in school. Thereby, they usefully questioned the commonplace assumption that reading is reading is reading. In contrast to this early work, we offer the much more complex taxonomy that we developed, and suggest that it paints a more accurate picture of the nature of literate activity at work than any studies we know of to date. To be content to say that reading at work is mostly "reading to do" is to overlook the many different functions that reading serves when people are reading in order to accomplish a task, and to underestimate the importance and prevalence of literacy in the workplace. Moreover, the categories "reading to do" versus "reading to know" give no sense of the political nature of literate activities in the workplace. As we have argued in this report, the kinds of literate activities that a person engages in at a workplace may have more to do with workers' rights and responsibilities and the limits and constraints set by management than with the nature of the work per se. Thus, we believe that this study indicates how very important it is to be precise and detailed when describing the functions that reading and writing serve in the workplace, and to be clear about how those functions relate to workplace hierarchies and power structures.

The study illustrates further, we believe, the value of ethnographic and qualitative research for understanding the skill requirements of work, and conversely, it suggests the ways in which studies that are based primarily on survey data and/or "grand tours" of the workplace may mislead. When we first began our research at EMCO, the plant manager assured us that literacy wasn't very important at the factory, and pointed out as well that most people there couldn't even read English. As we have demonstrated, he was wrong on both counts. Even at Teamco, with its intense interest in the team concept, the role and importance of literacy went unrecognized. Yet, we have seen that both factories were awash with paper, and that at Teamco, an important part of being an effective team member was developing what we have called a "literate identity."

To take another obvious example of how things aren't what they seem from a survey or quick tour, at the beginning of our research project we employed a local consulting firm with contacts among Silicon Valley circuit board manufacturers to conduct a telephone survey. We intended to use this survey to help us with a first rough cut—to identify factories on both ends of the continuum of "traditionally organized" and "high performance." However, it was unhelpful even in uncovering broad trends. The answers that EMCO gave to this survey suggested that this company fit the "high performance" profile, when in actuality—as we learned from our ethnographic field work—it did not. To complicate the picture even more, although certain of Teamco's practices came much closer to the high performance ideal than did EMCO's, certain characteristics that one associates with Tayloristic work environments were also alive and well at Teamco. Thus, to be blunt, when we read reports that make grandiose claims about skills and the relationship of skills to work organization, and when these reports are based solely on cursory interviews or questionnaires and quick factory walk-throughs, we think they should be viewed with skepticism—if not taken as a grain of salt.

The project complicates the notion of "high performance" work environments. We have already said how hard it is to tell if a particular factory is genuinely high performance, but the complication only begins there. Appelbaum and Batt (1993) have observed with a critical eye that the US response to workplace innovation has been to try it on piecemeal, adopting a few isolated practices, for example, associated with quality enhancement programs rather than the whole ball of wax. This characterization, while accurate for many companies, we are sure, does not quite get at the problems we saw surfacing at our high performance factory. It's hard to imagine a much more whole-hog approach to reorganization around teams than Teamco's. What seems to be the case for that factory, and we suspect for others, is that it is quite possible for high performance innovations such as self-directed work teams to co-exist comfortably with Tayloristic, hierarchical work processes and Tayloristic notions of how to introduce change. Teamwork at this high performance company was directly connected with, and its success completely measured by, the improvement of quality and productivity rates. But this did not mean that workers performed their jobs differently or that the traditional plant hierarchy was rearranged or challenged. Those interested in workplace reform and high performance innovation have a long row to hoe, both in implementing change and in understanding and circumventing resistance to it.

Little attention is usually paid by those in charge of workplace innovation to who workers are—their backgrounds, their biases, their goals in their current job, their plans for the future. We began this research project with an interest in how people on the front-lines of economic change manage to imagine and construct careers, and we have collected remarkable and varied stories that speak to this issue. But in the course of learning what we have we've also become aware of how little management seems to know about its own workers, and how this lack of knowledge can and does backfire, contributing to quiet but persistent and detrimental resistance to company-valued projects and practices. Sometimes the lack of knowledge is as blatant and blanket as erroneously assuming that the foreign-born workers from particular ethnic groups are illiterate and therefore incapable of taking part in work activities that require reading. Other times it is more subtle, such as failing to take into account workers' political ideologies. "Which is better," one Vietnamese team member demanded of us, "one leader who knows what he's doing or many leaders who are trying to lead but don't know how?" She went on to state with considerable indignation that she had not fled communism in her country in order to embrace it at her job. Such was her response to the company's practice of requiring workers to rotate as team leader. We have many examples of similar confusions and mistaken perceptions. Only good can come, we would argue, from learning who your workers are. And big-scale cultural change at a workplace is probably impossible without it.

To say that mangers and others in supervisory positions frequently don't know their workers is not to demonize them. If we have learned something about the variety in workers' backgrounds, we've also learned, to the contrary of many opinions on the left, that managers aren't all cut from the same piece of cloth. To speak of management as a monolith is obviously to make as egregious an error as to assume that all workers are similarly lacking. One of the most hopeful parts of this study has to do with the role that people in authority can play in creating humane spaces for individual and collective agency in the workplace, whether it's high performance or not. We came upon this insight as we were analyzing who performed what kind of literacy-related task. We noticed moments at our traditionally organized factory in which front-line workers were unexpectedly able to exercise critical faculties, negotiate solutions to problems, and in general to act in self-directed, responsible ways. These moments had nothing to do with workplace ideology or organization and in fact occurred, one could say, in spite of them. They happened, rather, as a consequence of people in authority—engineers, supervisors, technicians—creating social spaces in which people felt respected and safe. In much of the literature on teams and workplace change, warnings are given regarding the recalcitrance of middle managers and their resistance to change, and we have witnessed this phenomena in our research. But we have also seen such managers find ways to help workers mediate traditional power structures and to make the workplaces more humane and fulfilling, despite the constraints of the capitalist system. And this is very hopeful.

We have illustrated in this report the ways in which literacy is woven throughout the fabric of circuit board assembly. We would venture that similar portraits will emerge from research in other industries, since modern day literacy requirements in manufacturing seem to be driven by an almost universal interest in and need for certification and record-keeping. A new requirement for today's world of work, then, is developing a literate identity as a worker—becoming adept at and comfortable around the paperwork that is part and parcel of everyone's work now on the manufacturing floor; learning to conceptualize one's work in terms of its written representations; being able to master and manipulate the social rules that govern literate activities in the factory.

It's still customary to talk about literacy in terms of basic skills and to urge schools, vocational programs, and adult literacy classes to teach these fundamentals. But our research argues for a vastly different way of viewing workplace literacy. We have shown the remarkable variety and number of functions that reading and writing serve in circuit board assembly. What will also surprise people about our list is how small a portion of the functions fall into our category of "basic," by which we mean relatively simple, self-contained tasks: copying, labeling, keyboarding, tallying. Our continuum of literacy functions quickly expands to include categories in which the purposes that literacy serves are first more complex—using literacy to explain, taking part in discourse around texts, participating in the flow of information, problem solving—and then to categories in which literacy is more obviously connected with issues of power—using literacy in the exercise of critical judgment, using literacy to acknowledge, exercise, or resist authority.

Contrary to popular opinion, workers don't just need the "basics," whether those basics are cast in a traditional mold of readin' writin' and 'rithmetic or re-cast as "higher order thinking skills" or other decontextualized competencies listed on various skill lists. We have observed workers using literacy for purposes that run the gamut of our categories. Indeed, our argument is that a literate identity means being able to do precisely that—being able, that is, to dip appropriately and as needed into a wide and deep repertoire of situated ways of using written language and other forms of representation in order to carry out a work-related activity.

Happily, virtually all of the workers that we have observed were able to rise to the occasion. Despite having to traverse boundaries of culture, language, class, gender, ideology, and work hierarchy, these workers for the most part have taken on the challenge of developing a repertoire of literate practices, and they are meeting it successfully. One only needs recall the picture of the front-line worker, the recent immigrant, standing before a roomful of managers, reciting from her graphs and charts, to recognize and appreciate the task and the achievement. In fact, the most formidable challenge for workers is not, we would argue, developing a literate identity, but being perceived as capable of doing so, of being fit for the occasion.

It is almost a truism of current literacy theory that reading and writing are connected to power, but rarely have researchers traced those connections empirically. In this project we have been able to demonstrate that particular functions for literacy—high prestige functions such as those associated with exercising judgment and problem solving—are most often associated with and available to those in positions of authority, such as supervisors, managers, and engineers. On the other hand, certain other functions that literacy serves—lower prestige purposes such as accomplishing simple, discrete tasks or using literacy to explain—are most often the categories associated with and available to front-line workers. Taking part in literate activities is not so much a question of ability, then, as it is a question of rights and opportunities. In other words, patterns of literacy use are generally linked to structures of authority. What this means, practically speaking, is that skills change when authority changes. Thus, one reasonable measure of whether a factory is truly high performance—of whether workers are actually imbued with the power to problem solve and to self direct—is the types of literacy workers are able to practice.

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APPENDIX A: MULTIMEDIA DATA BASE

Early on in our project, as we learned more and more about the literacy requirements of work, along with the rights, responsibilities, and the constraints that are placed on exercise of literate skills in changing workplaces, we began to consider how we might introduce others to our research. A too familiar problem for researchers is how to make one's work accessible, interesting, and useful to a wide range of lay people or non-specialists—including educators, policy makers, leaders in business, industry, and labor, as well as the general public. In previous research (Hull, Rose, Greenleaf, & Reilly, 1991; Reilly, Hull, & Greenleaf, 1992; Greenleaf, Hull, & Reilly, 1994), we had found it effective to make portions of our qualitative data available to educators for their own analysis, reflection, and interpretation. Thus, in addition to writing research reports and journal articles about our work, we constructed print- and computer-based materials which present qualitative data—for example, segments from interviews, samples of texts, excerpts of classroom talk—and which ask teachers to construct their own accounts of the teaching and learning represented by the data. This strategy is based on the view that educators are rational, "problem-solving professionals, who apply beliefs, theories, and knowledge to their work" (Schön, 1989), and it draws as well upon the "case method," which increasingly popular in both business and teacher education (e.g., Schulman, 1990).

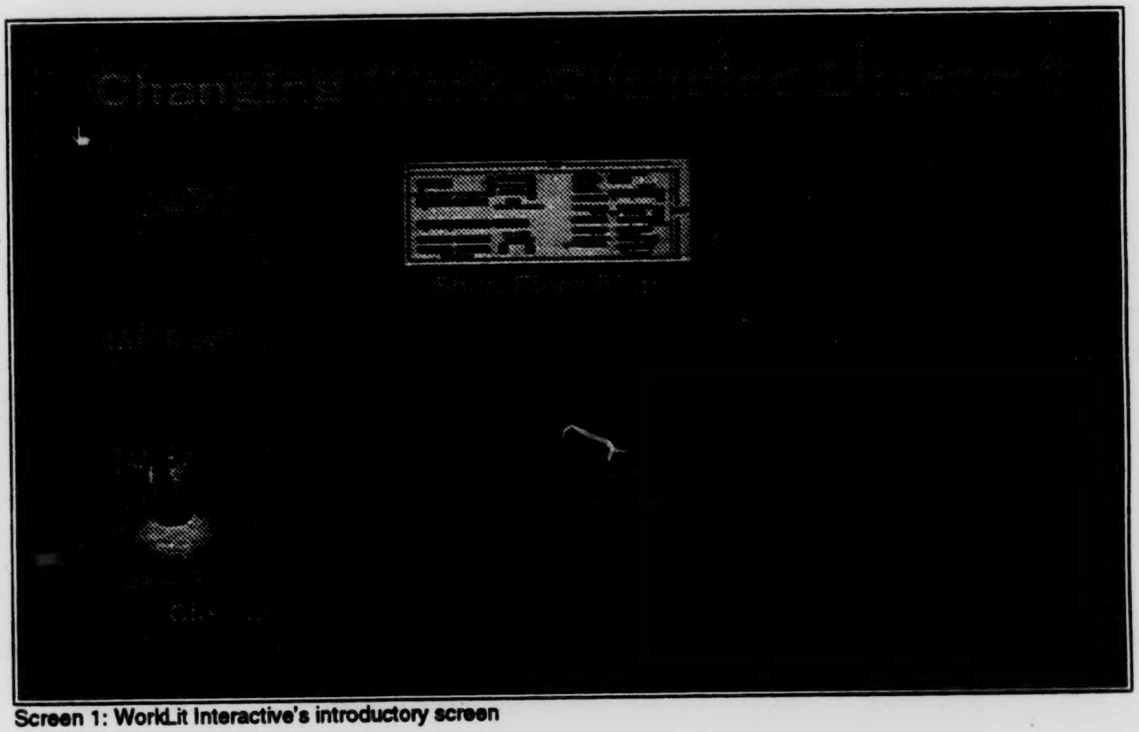
From the start of our project, then, we considered how we might eventually share our data and our findings with multiple lay audiences—vocational educators, literacy specialists, writing teachers, researchers, managers, and policy makers. While each of these audiences has different interests, expertise, and points of view, we nonetheless hoped to present our data in such a way that most people could quickly see for themselves how literacy occurs and obtains its significance through events within the workplace and from the larger context in which the events are situated. At the same time, however, we wanted to avoid the pitfall of reducing the complexity of the social and structural relationships that surround literacy within the workplace. Our solution to these potentially conflicting goals has been to design an interactive multimedia presentation of our findings. We have begun to build this tool, which we call "WorkLit Interactive," and we expect to complete it in 1996.

Presenting our findings through WorkLit Interactive enables us to do several things. First, we can represent our data within the sensory and culturally rich context in which they were found, quickly familiarizing our audiences with our sites. This is particularly important for a project in a workplace, because businesses and the literacy-related work that takes place in them aren't easily visualized. Multimedia also enables us to use iconic cues and multiple windows to show how several factors simultaneously influence events; for example, we can link an unfolding event with the background data influencing it. Finally, an interactive multimedia format allows us to present our own analysis of events, while at the same time respecting the intellectual diversity of our audiences by supporting their freedom to explore the data in many different ways so that they may draw their own conclusions.

Below we describe our process for designing and building WorkLit Interactive, and we also attempt to give a sense of what the completed data base will be like. Throughout this section we attempt to foreground the ways in which the design of this tool has been influenced by the data we have collected, our theoretical stances towards that data, and our methods of analysis.

As we explained early in this report, our basic units of analysis for our research have been work events, team meetings, and classes or training sessions. As we will shortly illustrate, it has made sense to use these units as an organizing principle for the data base as well. But much as we began our own field work by getting an understanding of the organization and dynamics of the factory and its industry, we believe WorkLit viewers will also require an introduction to the factories we studied and to the research project as a whole. And once inside a work event or meeting or training session, a viewer might well need access to background information on the participants and definitions of technical terms, as well spatial and temporal information on where the activity was taking place within the factory—information that over a period of three years had come to inform our own analysis. Therefore, while the heart of WorkLit Interactive is its presentation of individual work events, team meetings, and training sessions, its interface attempts to provide ready access to all the information a viewer might need for understanding and interpreting the data.

When viewers first click on WorkLit's HyperCard icon, they come to the software's introductory screen (see Screen 1). Here they are able to move directly into one of several different modules for both the traditionally organized and the high performance factories: an individual work event (see Screen 2), team meeting, or training session; an interactive map of the factory floor; a collection of key participant's work life histories; a glossary of technical terms; introductory information on the project; and a summary of findings from the project. While access to individual elements in each module will be drawn upon as background within individual work events, through this introductory screen, viewers can move directly into a particular module. We will now tour each module and the decisions made in its design.



Screen 1: WorkLit Interactive's introductory screen

By clicking on the introductory screen icon labeled "Introduction," the viewer will move to a window that provides access to a series of subject headings. When a particular subject heading is clicked upon, a window appears with bulletted textual descriptions of the project's major elements. Viewers can either move serially through these screens as if reading a written report or click only on those subjects of particular interest to them. Having this information readily accessible in a bulleted fashion should allow viewers to easily find information concerning the project's goals, method, or scope.

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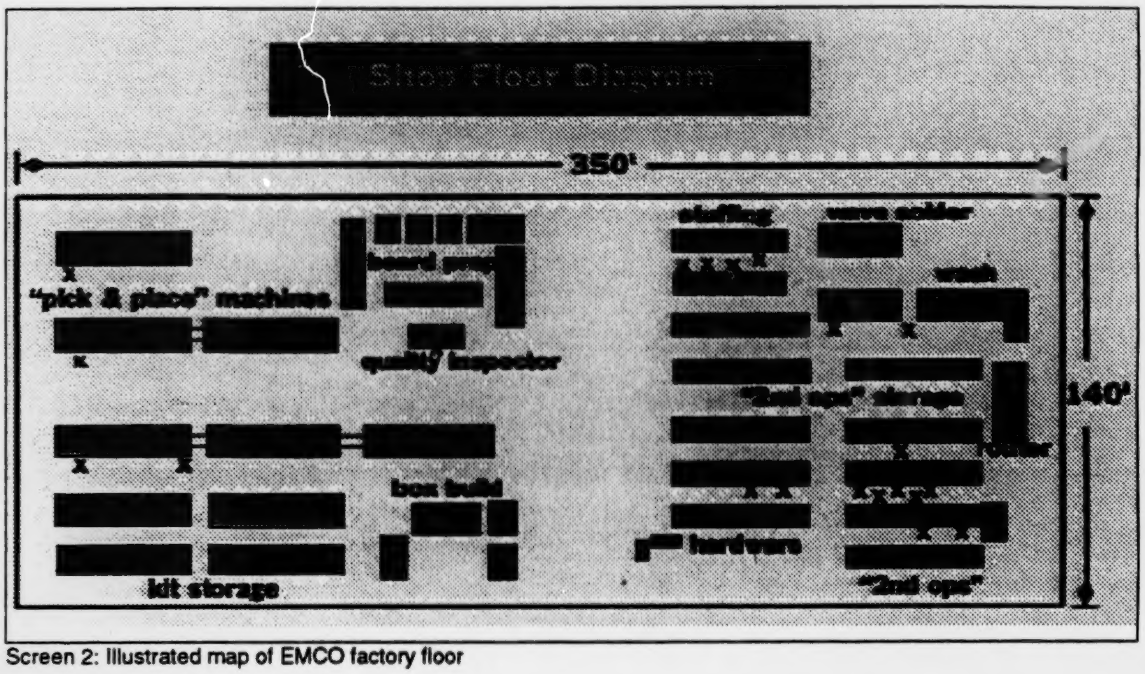
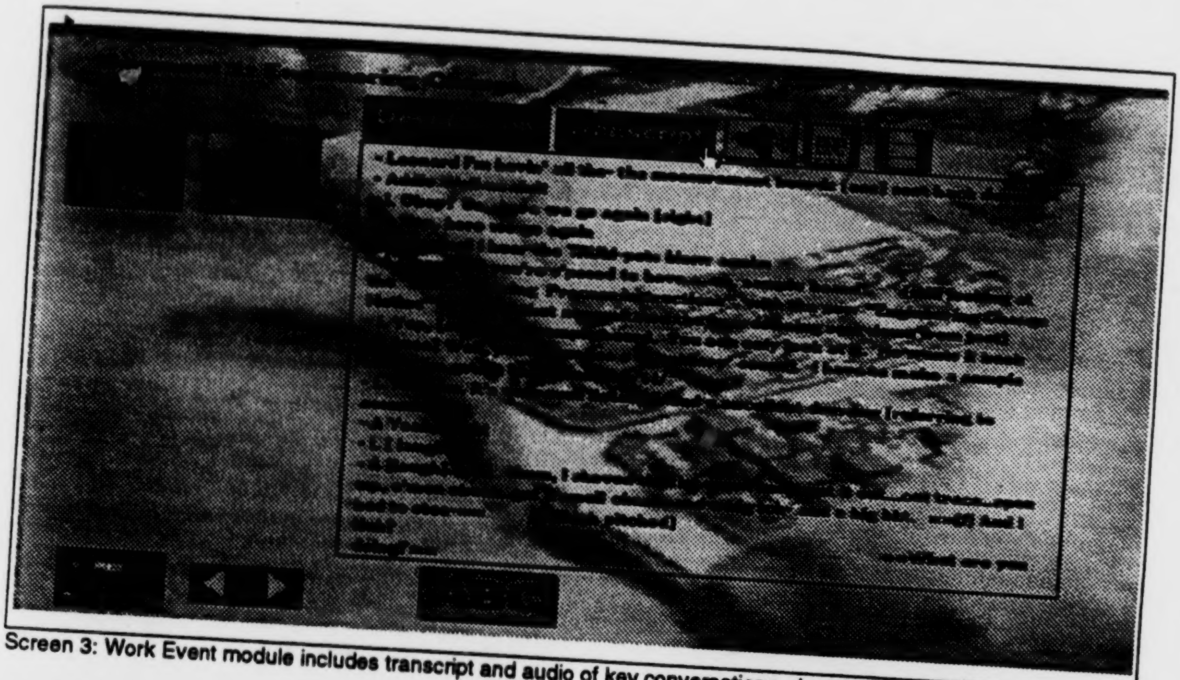
In order to situate work events graphically within the factory and the manufacturing process, we've created an interactive illustrated map of a factory floor (see Screen 2). This illustrated diagram of the shop floor allows users to walk metaphorically through the factory, looking around by viewing video clips (QuickTime movies) at different locations. We feel that using video in this manner provides a particularly effective way of quickly familiarizing viewers with the factory environment.

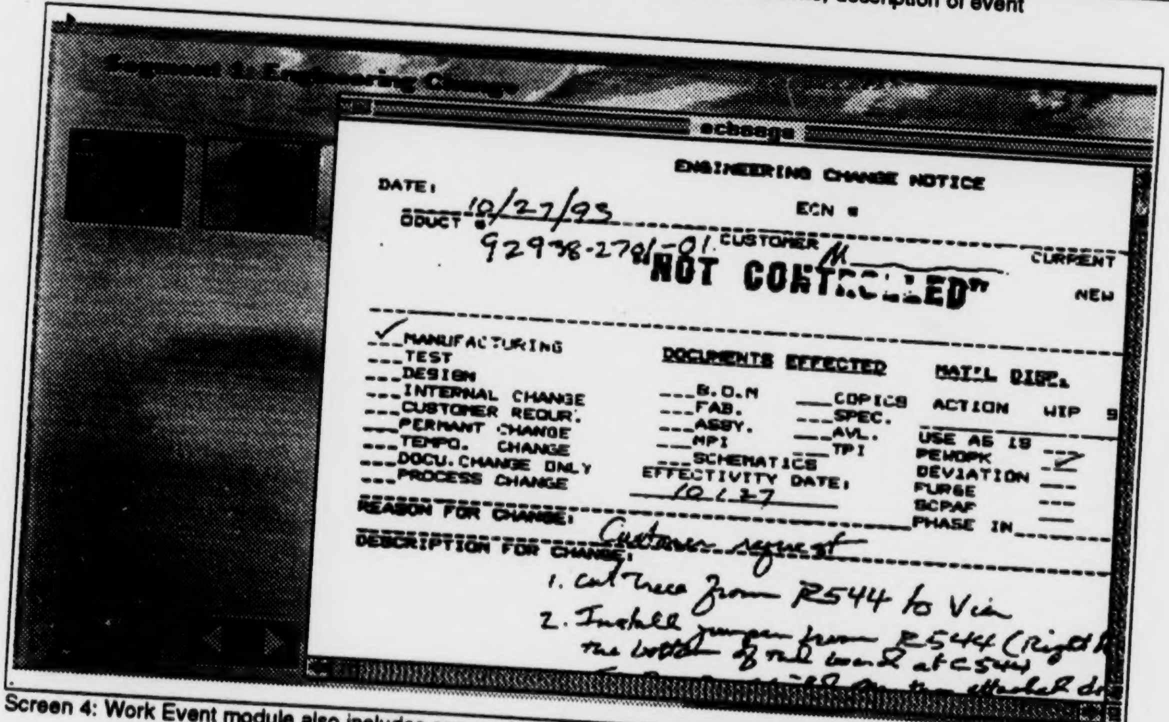


Screen 2: Illustrated map of EMCO factory floor

Each work event or team meeting or training session is divided into screens by the segments of the activity. Segments include a text situating and describing the activity, photographs of the key participants, a transcript of that portion of the activity, and the audio of that particular segment which we collected by shadowing workers or working alongside them. Thus far we've constructed one work event for our multimedia software, the engineering change that serves as the first narrative in this report (see Screen 3). Readers will recall that this common work event occurs when a customer decides to alter the design of a circuit board and issues directives to that effect to the engineers at the factory. Production is then stopped, previously completed boards are recalled, and changes are introduced into the production process as outlined in re-work instructions. Within this work event module, we include scanned images of the documents referenced, audio and transcripts of key segments of conversations in which the engineer and supervisor negotiate the documents and decide how the work will get done (see Screen 4).



Screen 3: Work Event module includes transcript and audio of key conversations, description of event



ENGINEERING CHANGE NOTICE

DATE: 10/27/93

ECN #

ODUCT #: 92938-2701-01.

CUSTOMER M

CURRENT

"NOT CONTROLLED"

NEW

✓ MANUFACTURING
___TEST
___DESIGN
___INTERNAL CHANGE
___CUSTOMER REQUR.
___PERMANT CHANGE
___TEMPO. CHANGE
___DOCU. CHANGE ONLY
___PROCESS CHANGE

DOCUMENTS EFFECTED

___B.O.M
___FAB.
___ASSY.
___MPI
___SCHEMATICS
___COPICS
___SPEC.
___AVL.
___TPI

EFFECTIVITY DATE: 10/27

MAT'L DISP.

ACTION WIP

USE AS IS ___
REWORK Z
DEVIATION ___
PURGE ___
SCRAP ___
PHASE IN ___

REASON FOR CHANGE: Customer request

DESCRIPTION FOR CHANGE:

1. cut trace from R544 to Via
2. Install jumper from R544 (Right
the bottom of the board at C544

Screen 4: Work Event module also includes scanned images of documents referenced

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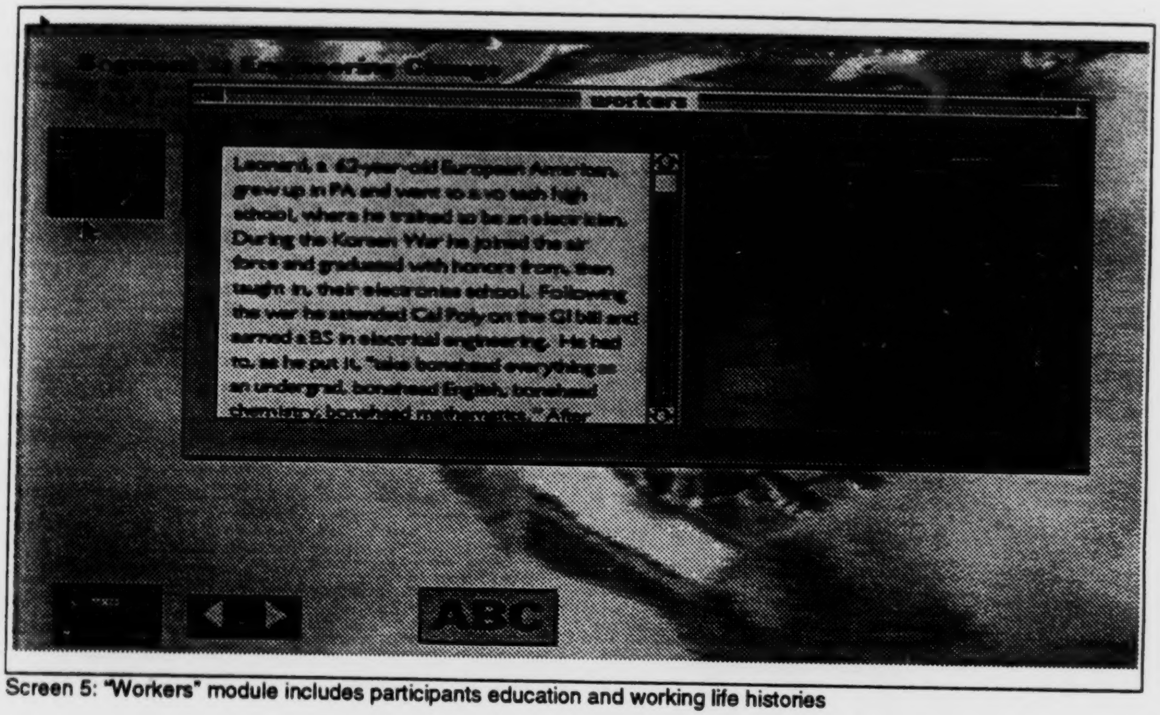
By exploring this work event, viewers can become acquainted with key documents that are written and read in electronics manufacturing, and they can also analyze what workers need to know about the role that literacy plays in the workplace, and how literacy practices are negotiated in the context of work practices. They can note who is responsible for writing and reading particular texts, and they can ascertain how printed texts function in conjunction with other forms of symbolic representation. This particular event (which later includes the conversations of Korean and Vietnamese workers about how to organize the work flow given the engineering change) should also provoke discussions of the role and importance of oral communication in a multi-cultural workplace, where many languages are spoken and not all workers speak or are perceived as able to speak and understand English.

The "Workers" module brings up a series of windows accessing working life narratives linked to photographs of the key participants within events or team meetings or class sessions (see Screen 5). Providing access to biographical narratives collected through interviews helps viewers understand how people's educational and work histories contribute to their perspectives. By accessing this module through the introductory screen viewers can browse through the collection of narratives. They can also access participants' working life histories directly from screens within each work activity module. These working life narratives are a rich source of information about the paths people follow or create as they navigate the institutions of schooling and work (c.f. Hull, 1993; Hull and Jury, 1994).

The "Analysis" module includes summaries of our findings for particular work events, team meetings, or training sessions, as well as overall project themes and findings. Viewers can not only read our analysis, but by clicking on buttons near a particular finding, they can see for themselves the actual interactions and practices which surround and comprise key events. Within each module, key themes are also highlighted and explained as they occur. By clicking icons representing key themes of analysis—such as literacy, cross-cultural communication, or collaboration—a viewer is pointed to relevant occurrences within that particular segment.

We have created a glossary of technical terms that enables viewers unfamiliar with electronics manufacturing to access a lay person's explanation of tools and processes referred to by participants. Users can access the glossary from the introductory screen. Throughout the text of an event or training session or team meeting, terms found in the glossary are also highlighted. Clicking on such highlighted text will conveniently call up a window with a specific definition for that term, then return the viewer to the text of the work event or training session or team meeting when the window is closed.



Leonard, a 62-year-old European American, grew up in PA and went to a vo tech high school, where he trained to be an electrician. During the Korean War he joined the air force and graduated with honors from, then taught in, their electronics school. Following the war he attended Cal Poly on the GI bill and earned a BS in electrical engineering. He had to, as he put it, "take bonehead everything as an undergrad, bonehead English, bonehead chemistry, bonehead mathematics." After

Screen 5: "Workers" module includes participants education and working life histories

We have also scanned in key documents referenced within work events, team meetings, and training sessions. Viewers can access a graphic archive of these documents as examples of the range of documents used throughout the factory. These examples are also linked to specific work events, team meetings, and training sessions so that viewers can actually see the documents being referenced as they enter into and follow an activity. For example, in Screen 4 viewers see the scanned image of the actual engineering change notice referenced in the re-work event module.

In general, then, we designed WorkLit Interactive so as to introduce educators and other lay people in dynamic fashion to the electronics industry, our factory sites and their manufacturing process, and the role of literacy therein. In effect, we put educators in the position of researchers, listening to conversations on the factory floor, examining the documents that direct the work, learning about workers' schooling histories and career paths and their hopes and dreams for the future. We think this multimedia software will enable educators and others to see and hear for themselves the many forces influencing the work and the learning that take place within the factory, it will allow them the closest thing to a firsthand look at the literacy skills that are important in changing work places, and it will promote reflection on how what they've learned might affect classrooms. This multimedia software might also provoke discussions about what educators have to offer industry, especially in terms of language learning, literacy theory and practice, and pedagogical issues in training.

We anticipate that the software will eventually include six to eight work events, team meetings, and training sessions, although that number may increase, depending on how quickly we are able to construct the data base. Eventually, we plan to press a compact disc version, so that this CD-ROM can be used by our funding agencies, the National Center for Research in Vocational Education and the National Center for the Study of Writing and Literacy, for dissemination purposes in future years. We hope it will also serve as a model for other researchers who have data that would be appropriate for inclusion in this kind of format.

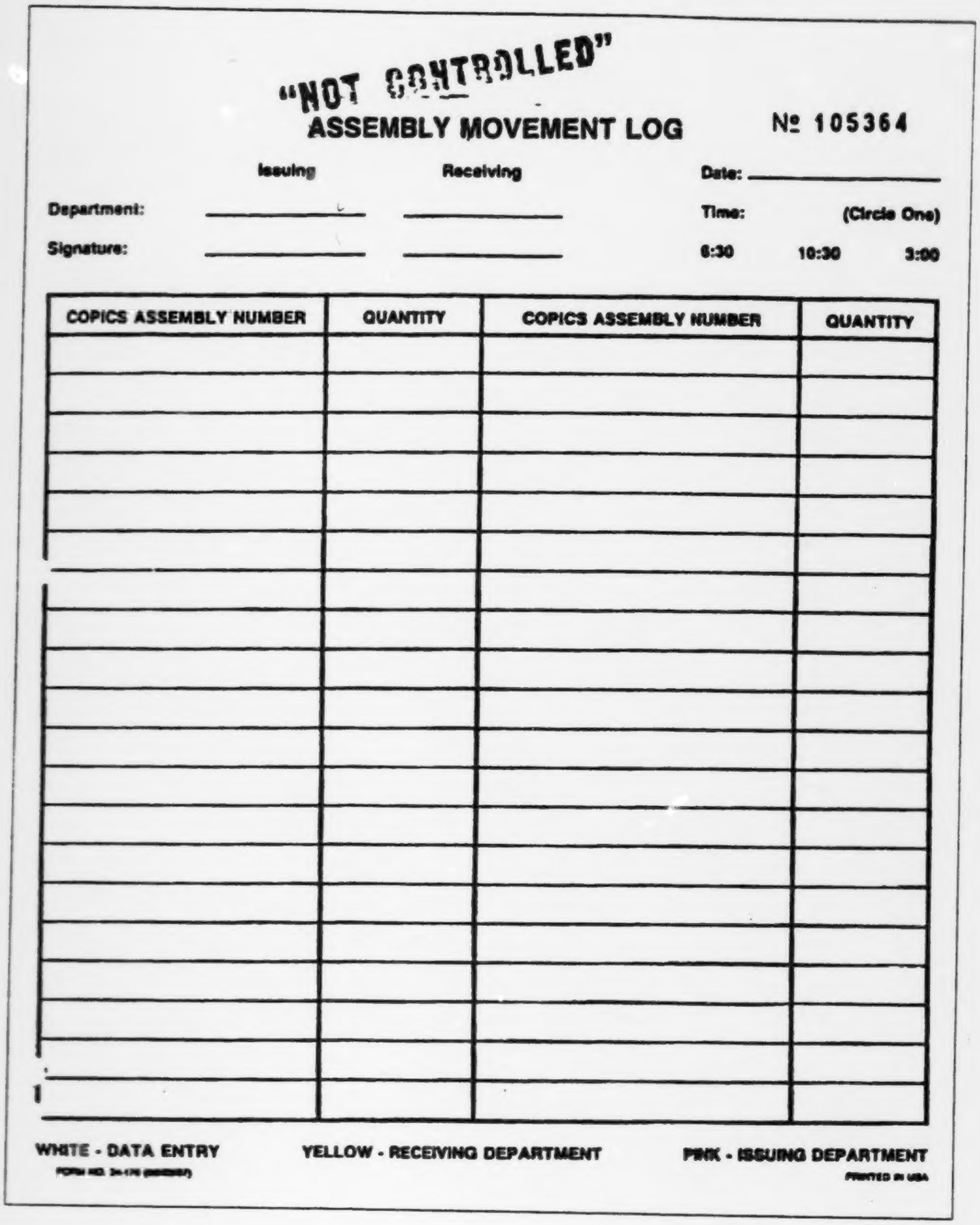
In addition to the above dissemination avenues, we would like to launch a different kind of effort with WorkLit Interactive. Specifically, we would like to convene groups of educators with an interest in literacy and/or school-to-work efforts, introduce them to the software, and document their responses (for an example of this kind of dissemination effort with print-based materials, see Greenleaf, Hull, & Reilly, 1994). Analyses of teachers' conversations about WorkLit Interactive will not only provide an interesting window on how well this particular multimedia tool functions, but also information about teachers' conceptions of workplaces and the process of re-imagining curricula in light of work. We think educators will have useful suggestions for business as well about teaching and learning—comments we hope to document as part of our research.

At a time when calls abound for school reform and a more properly prepared workforce, and when the usual response to such calls is a list of worker competencies, our goal has been to construct a holistic picture of the workplace, including a description of the socio-cognitive nature of the work, and especially the role of literacy within it, and an account of the way that work is embedded within a socio-cultural work setting and organizational history. We hope this research does justice to the challenges facing the people and the factories we have studied and the complexity and pressure of the changes which characterize working lives. And we hope our multimedia software does justice to our research, making it accessible and more meaningful for multiple and distant audiences who may eventually have an effect on how work is organized, how workers are viewed, and how training gets done.

APPENDIX B: CLOSE TRANSCRIPTION KEY

acc	accelerated tempo
/	final phrase marker
f	fortis enunciation
p	piano enunciation
. .	speech pause (one second per mark)
(xx)	unintelligible word or phrase; x = one syllable
( )	unintelligible section; unable to distinguish syllables
=	overlap (simultaneous speech)
==	latching (one speaker following immediately after another)
?	rising intonation
-	cutting off phrase or word
caps	stress

APPENDIX C: MOVEMENT LOG FORM



"NOT CONTROLLED"

ASSEMBLY MOVEMENT LOG № 105364

	Issuing	Receiving
Department:		
Signature:		

Date: ____________

Time: (Circle One)

6:30 10:30 3:00

COPICS ASSEMBLY NUMBER	QUANTITY	COPICS ASSEMBLY NUMBER	QUANTITY

WHITE - DATA ENTRY YELLOW - RECEIVING DEPARTMENT PINK - ISSUING DEPARTMENT

FORM NO. 24-170 [illegible]

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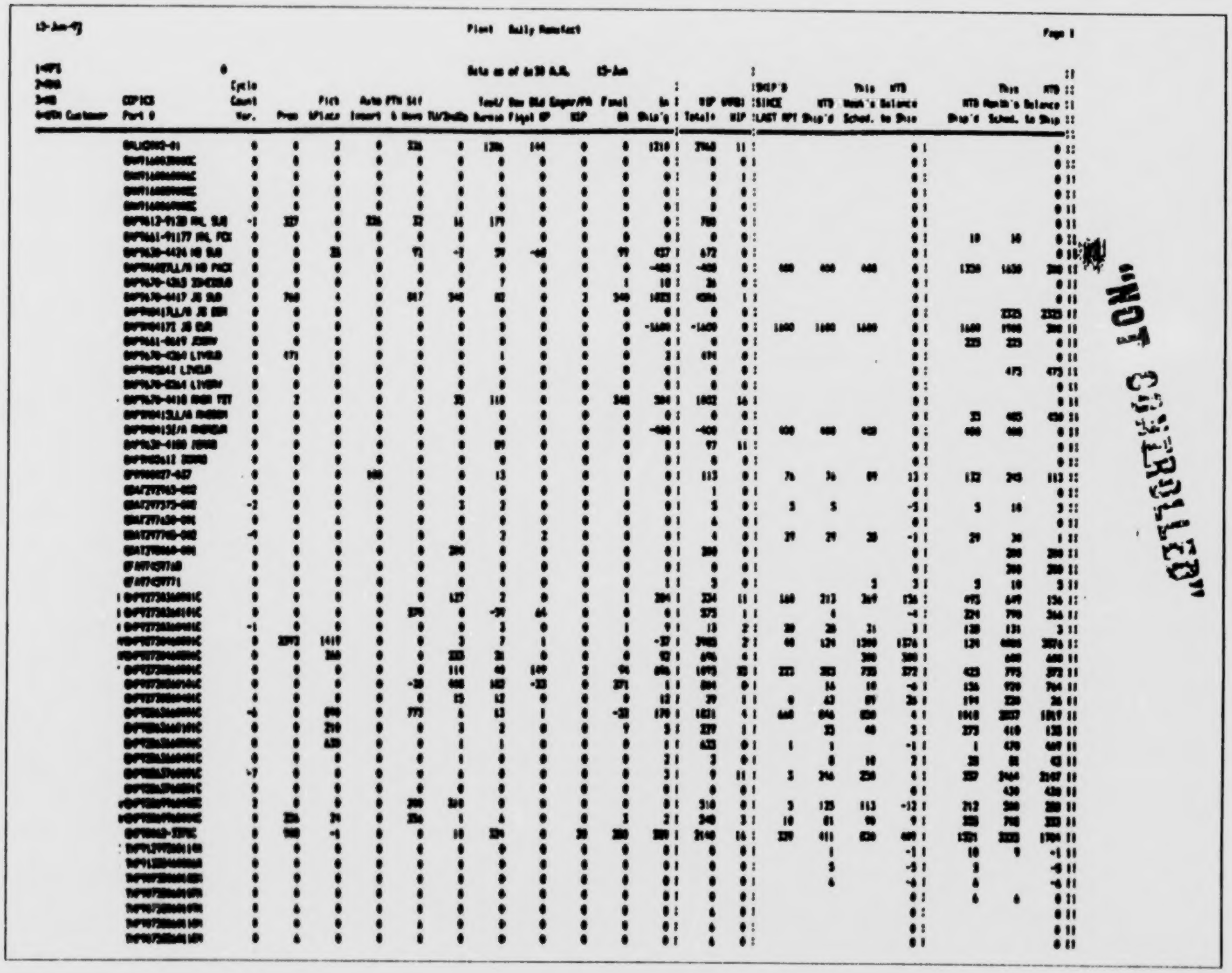
APPENDIX D: WORK IN PROCESS (WIP) REPORT



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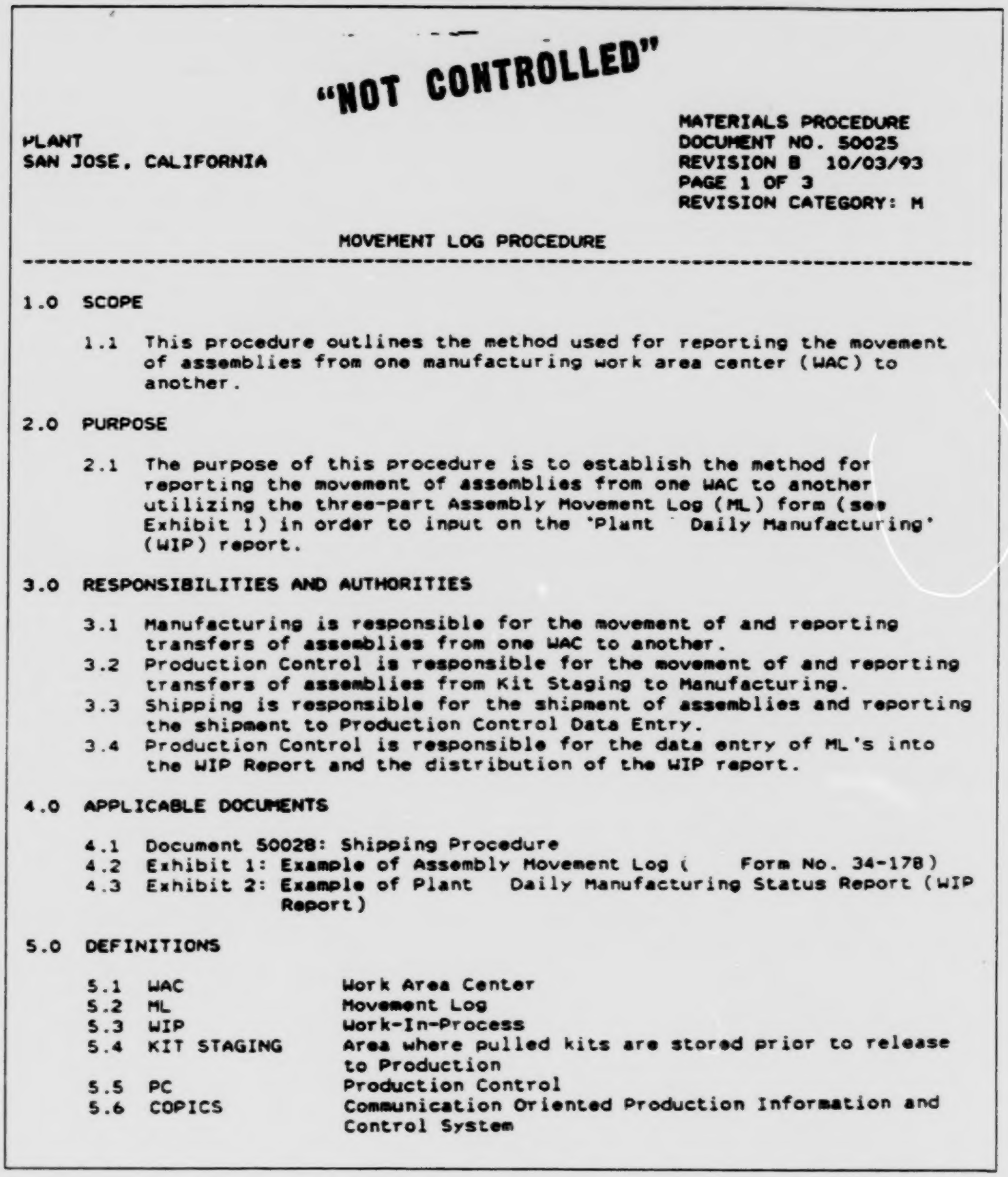
APPENDIX E: MOVEMENT LOG PROCEDURE.

Such procedures such are written for every process, every responsibility in the plant.



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PLANT
SAN JOSE, CALIFORNIA

MATERIALS PROCEDURE
DOCUMENT NO. 50025
REVISION B 10/03/93
PAGE 1 OF 3
REVISION CATEGORY: M

MOVEMENT LOG PROCEDURE

1.0 SCOPE

1.1 This procedure outlines the method used for reporting the movement of assemblies from one manufacturing work area center (WAC) to another.

2.0 PURPOSE

2.1 The purpose of this procedure is to establish the method for reporting the movement of assemblies from one WAC to another utilizing the three-part Assembly Movement Log (ML) form (see Exhibit 1) in order to input on the 'Plant Daily Manufacturing' (WIP) report.

3.0 RESPONSIBILITIES AND AUTHORITIES

3.1 Manufacturing is responsible for the movement of and reporting transfers of assemblies from one WAC to another.

3.2 Production Control is responsible for the movement of and reporting transfers of assemblies from Kit Staging to Manufacturing.

3.3 Shipping is responsible for the shipment of assemblies and reporting the shipment to Production Control Data Entry.

3.4 Production Control is responsible for the data entry of ML's into the WIP Report and the distribution of the WIP report.

4.0 APPLICABLE DOCUMENTS

4.1 Document 50028: Shipping Procedure

4.2 Exhibit 1: Example of Assembly Movement Log (Form No. 34-178)

4.3 Exhibit 2: Example of Plant Daily Manufacturing Status Report (WIP Report)

5.0 DEFINITIONS

5.1	WAC	Work Area Center
5.2	ML	Movement Log
5.3	WIP	Work-In-Process
5.4	KIT STAGING	Area where pulled kits are stored prior to release to Production
5.5	PC	Production Control
5.6	COPICS	Communication Oriented Production Information and Control System

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"NOT CONTROLLED"

MOVEMENT LOG PROCEDURE

6.0 PROCEDURE

6.1 When a quantity of assemblies is ready to be moved from one WAC to another, the issuing department's material handler consolidates like assemblies onto the proper carrier and fills out a ML.

6.2 On the top of the form, the material handler will fill in the date, the Issuing Department name, the Receiving Department name, and the time of day.

6.3 The material handler will then fill in the COPICS assembly number(s) for the assemblies to be moved. Use the WIP Report to confirm that the part number is correct. The ML will accommodate up to forty (40) different assembly numbers.

6.4 The material handler then counts all the assemblies to be moved and fills in the quantity for each next to the appropriate assembly number.

6.5 The material handler then initials the signature area located under the Issuing Department name signifying that all the information on the ML is correct (special attention should be paid to the assembly number and quantity).

6.6 The Issuing Department material handler will then move the assemblies and the ML over to the Receiving Department and alert the Receiving Department material handler that the assemblies are ready to be transferred.

6.7 While the Issuing Department material handler waits, the Receiving Department material handler will confirm that all the information on the ML is correct (including assembly number and quantity). If any portion of the ML is incorrect, the Issuing Department material handler must adjust the ML and initial the correction. When all information is correct, the Receiving Department material handler initials the signature area located under the Receiving Department heading.

6.8 The Issuing Department material handler will then separate the ML, giving the yellow copy to the Receiving Department material handler along with the assemblies. The Receiving Department material handler will then move the assemblies to production and file their copy of the ML.

6.9 The Issuing Department material handler will file the pink copy of the ML and turn in the white (data entry copy) into the red in-basket located next to the Manufacturing Manager's office.

6.10 The Production Control data entry clerk will pick up the white ML's throughout the day, with the cut-off for movement s being 6:30 AM the next morning, for input into the WIP Report (see Exhibit 2).

6.11 The only exception to the above is how the Shipping Department utilizes the ML's to report shipments. The quantity entered will be the quantity shipped to the customer per Document 50020. Since

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MOVEMENT LOG PROCEDURE

there is no WAC to act as the Receiving Department for shipments, the Receiving Department on the ML should be entered as 'DATA ENTRY' and no confirmation on assembly numbers, quantity, etc... can take place. The Shipping Department still forwards the white copy to the red in-basket, but will retain both the yellow and pink copies.

7.0 COMPLIANCE

7.1 All Plant personnel will comply to this procedure any time assemblies are moved from one area to another.

7.2 Non-Plant personnel are prohibited from transporting assemblies into, out of, or within Plant .

8.0 RECORDS

8.1 Each affected area/department will retain their Assembly Movement Logs for a minimum of four weeks. After four weeks, the ML's may be shredded.

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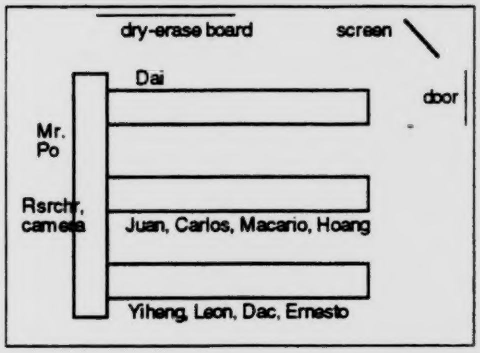
APPENDIX F: COMPLETE TRANSCRIPT
WAVE SOLDER TEAM MEETING

Summary: Wave Solder Team. As with all their meetings, this takes place in the training room, 9:00-9:30 on a Monday night. Hoang, the team lead, is present but has laryngitis so sits out with the masses, allowing Dai, the minutes taker, to serve as lead. As the tape starts, Carlos tries to coax Hoang into sitting up at "the head table" (in this team's meetings, the minute-taker and leader always sit at the front table, apart from and facing the rest of the team). Carlos assures her she "won't have to talk," that it's her last week as leader and so she should just sit up there. She doesn't go for it, remains seated with the masses, and the meeting begins. Present are Dai Le, team leader and wave area lead; Yiheng Li, operator; Leon Fuentes, operator; Carlos Garcia, wave technician; Hoang U, wave QC; Juan Sanchez, utility infielder (solder pot operator, board catcher, wave operator, hazardous materials handler...); Ernesto, board catcher at end of wash machine; Macario Antonio, operator, board catcher; Mr. Po, coach; Dac Nguyen, board catcher and wash machine loader. Three members are absent: Ngoc Tran, board catcher; Genaro Lopez, board catcher and wash machine loader; and Dinh Tran, operator.



Carlos: [looking around room, noticing Dai at front table by himself, Hoang seated out with the masses] Who's..? [to Hoang] I thought this- it's not teamwork!

[Hoang's hoarse reply inaudible]

Carlos: [to Hoang] You don't have to talk.

Dai: [something incomprehensible to Hoang]

Carlos: Yeah. You don't have to (x). This your last week.

[Hoang signs that she can't talk]

Carlos: That's OK. That's OK, go over there. Please. Please. No no no. [Carlos gets up and leans over toward Hoang, trying to coax her to take a seat up in the front of the room by Dai. She tries to explain that she is sick and has no voice. Carlos persists, but Hoang refuses.]

Dai: Forget her because she she has lost she kinda sick today. So I be here for last meeting.

Carlos: Um how 'bout next week?

Dai: Huh?

Carlos: She go up there again.

Dai: You expect she over here and sit and talking and everything like that but she cannot talking. [addressing full group] Meeting today we uh

Carlos: Last week.

Dai: No. Today we, how many member we absent, three.

Carlos: 'K, three.

Dai: Yeah, Ngoc um

Juan: Dinh.

Dai & Juan: Genaro, and Ngoc. And

Carlos: Dinh.

Dai: Dinh. So all the member we have now. Now I review last week. [reading/talking from minutes in binder] Last week the meeting we talk about problem-solving. And the board from the ( ) zero zero eighty-six. We talk about finding the IC.

Leon: Mhmm.

Dai: But for all the wave we didn't have any problem any more.

Leon: Yeah because we solve already the problem.

Dai: Yeah. We solve them. Then the board, 3Com two one thousand two, I think they need a fixture but I don't know if it's here.

Carlos: Yeah, I told to John Tucker already.

Dai: And 3Com four five zero six also.

Leon: The other one too. seven oh four.

Carlos: Yeah, seven oh four.

Leon: We need more fixture for that assembly. Only five. We need two or three more fixture.

Dai: Then our productivity, operators cannot be good every time wash machine, go to ( ) and back. We just count the machine the wave only. Give ( ) Then accepting all operator must count board before they start. Mr. Po want all operators put their component any time. We want better quality from the line. In loading SGI also high connectors sometime. The manager complain about productivity. Sometime high, sometimes low. So no ( ) productivity. If the machine have problem needs fix, fill out, even one minute, get it down so we what going on. Please report the times right away to supervisor. So that's last meeting's minutes.

Carlos: What's our agenda for tonight?

Dai: So, agenda tonight, everyone ( ) too ( ) before holiday, right? I talk about last week. ( ) We don't have any problem. We didn't have any complaint.

Leon: Really, huh?

Dai: Everybody ( ) Things were good. And now, we don't have the holiday. So we start today the fourth week, so ( ). Productivity not going down but not going up.

Leon: No, my productivity today tonight

Dai: For last week.

Leon: going down. (laughs)

Dai: Yeah. So ( ) not going too fast, nothing too slow. Is good. Is very good. So you don't have confusion, you don't have any questions to ask, what? If we give feedback all the time. [5 second pause] So everybody enjoy holiday uh I mean long weekend? I think is only me. (laughs)

Carlos: You only in- you're the only one who enjoyed the holiday.

Dai: I not enjoy

Carlos: Because you did not work Saturday, Sunday.

Dai: (laughs) [4 second pause] And now, we got to talk about, so about solder over there, everything OK with you now?

Juan: Who, me?

Dai: Uh huh.

Juan: Acuson?

Dai: No, all the 3Com over there. Solder pot working now?

Juan: Oh yeah. Is good right now.

Dai: OK.

Juan: 'S OK

Dai: So anyone have any...

Leon: No, I have a suggestion.

Dai: Sure.

Leon: Could you please remind uh whoever do that to put the tape, you know the masking tape in the in the gold finger? You know? They put the tape very loose. That's why when I wave now without fixture? You know? The board fell down two times. That's my problem.

Dai: OK.

[pause]

Carlos: [to Dai] So. What do we do?

Dai: You can see it when you put board

Leon: No, better to talk to the

Carlos: Better feed back to hand load.

Leon: who did that uh job, because to remind them that they need to to tight masking tape in the the you know the board.

Dai: But then actually, you know, 3Com sixty-five sixty-nine

Leon: Uh huh.

Dai: all the 3Com fixture, they not, you know, expect to wave like that either. Remember to use universal fixture. ( ) Set for board. Engineer, they not allow you to wave any kind of board without fixture.

Leon: But but that that uh board, there's no fixture, right?

Dai: Yes, right. That's when we use universal fixture. If because now we try to wave like wave ( ) and not set for board, board overflow, whatever? We think because we adjust it with your eye how much ( ) you have. But sometime like happening like two board dump. ( ) whenever and now we

Leon: No, no. I try to wave without fixture that you know that assembly, you know? Because the finger now in the Electrovert, they change already.

Dai: Oh ( ) already?

Leon: Uh huh. Yeah. It's good now. That's why I wave without fixture.

Dai: That's um I think from hand load problem, not from first mechanical.

Leon: Really? That's why I ask you to .. to remind them.

Dai: Sure. I will.

Carlos: Yeah, I relay the problem already. Tonight.

Dai: ( )

Carlos: It's not from first mechanical, it's from hand loading.

Dai: I know.

Carlos: They put tape before they load.

Dai: Hand load is doing that job too?

Carlos: I reminded them not to use the the bigger tape. Because not only they waste materials but they also are a problem with wave.

Leon: Even uh even I use a universal fixture, you know, if they put too much tape, we have problem too because some board have missing because of the thickness of the, yeah.

Dai Yeah. Let's see. Does anybody have any question to ask? Yiheng! Wake up.

[4 second pause; Yiheng takes sip of tea]

Yiheng: I'm very sleepy, Leon.

Leon: You're OK now, huh?

Yiheng: Yeah.

Leon: You have no problem in your area?

Carlos: We have- we have-

Yiheng: No, sometime.

Leon: Sometime.

Yiheng: Sometime, yeah.

Carlos: Yiheng. Yiheng. Basically we had uh feedback from Acuson that the board uh seventeen nine one two? Uh

Leon: Solder balls?

Carlos: Yeah, solder balls coming up again. Eighteen uh eighteen .. seventy-two, I don't know. Eighteen one-

Yiheng: Two eight seven

Carlos: three two

Leon: Or maybe one seven ( )

Carlos: They have solder balls. That's, we talk about them this afternoon? [to Dai] Did you have the the quality report?

Dai: Yeah. Oh. [looks in notebook for report] How come they (go same direction) how come solder balls, maybe somebody change the profile, I have no idea. But the long time already we been doing that board sent (for) building six.

Carlos: No, not only not only seventeen nine one two. But there are still a lot of, two more assemblies.

[Dai pulls report out of notebook, hands it to Carlos]

Carlos: Lemme see. [flipping through report] Uh .. we have, every week we have uh weekly quality meeting uh here in this room, so this afternoon we have a meeting with uh everybody on line and I'll show you Acuson problem. [finds page he'd been looking for.] Acuson. Yeah. [begins to read, holding paper out to the side as if for others to read along with him, using his finger to underline words as he reads] "Assembly seventeen nine one two, two two six four two, and eighteen one three two. Solder balls."

[Carlos hands paper back to Leon and Yiheng, and they read it silently as Carlos continues]

Carlos: 'K. If if you wave that kind of board uh just lower the pressure to ten. 'K? Yiheng? Because if you have excess flux and uh too fast you will create solder balls because of you not really drying up the flux.

Yiheng: Maybe too fast?

Dai: No.

Leon: Or maybe the fluxer nozzle-

Dai: Flux is too much.

Yiheng: Yeah. One eight one three two. Yeah. Acuson small one.

Carlos: Mm.

Leon: How 'bout the fluxer nozzle?

Carlos: No before before we we fix the problem already. But now it's coming back again.

Yiheng: Oh yeah. (Finger) problem.

Carlos: It's- look like-

Yiheng: (probably) finger finger problem

Carlos: If this a if it's it's a recurring- recurring problem. If if the customer's, you know, the customer give back have a feedback and then the graph would show like we have solder balls and then and then uh Acuson comes over here and says, "Well what's happening," and then drops. [gestures to represent rising & falling graph] After a while again, we have solder balls again. So it's doing like the same cycle so if we can you know control the flux of 'specially this type of boards.

Leon: We always find solder balls.

Carlos: 'K, Hoang?

Hoang: Hm?

Carlos: Please, please check this especially this three assemblies.

Hoang: Show me [reaches out her hand for report. Yiheng and Leon pass it to Carlos who passes it to Hoang. She reads as conversation continues.]

Yiheng: Assembly is a small one.

Leon: D'you check the board after

Carlos: [to Hoang] We have we're getting solder balls again.

Leon: it pass through the fluxer. Check if a lot of so you can adjust the

Yiheng: Not every board. Just a sometime. I I know this uh conveyor finger problem.

Leon: Not, not every board.

Yiheng: This every board?

Leon: Some, some

Carlos: Every.

Leon: Every board.

Carlos: Yeah.

Yiheng: Every board?

Leon: So.

Carlos: More than fifty percent.

Yiheng: Uh, last week (Saturday)?

Carlos: Not wave but it has been waved couple of weeks ago. A couple of days. Just recently.

Leon: Check the board. After the board passing out of the fluxer nozzle? [mimes lifting & inspecting board] Check the board. The bottom? Check if the too much flux.

Yiheng: Too flux.

Leon: Uh huh. Too much flux? Adjust the.. [mimes turning dial] that's better.

Carlos: [to Dai] Why don't you get a very quick uh..uh fishbone diagram for for the solder balls.

Dai: [to Carlos] I don't think he understand why to have solder balls and why adjust the fluxer down to ten for flux pressure. [to Yiheng] You know why? Because when the flux hit the bottom side too much, make the board on bottom wet. Then board be too ( ) it not have enough to make the board dry before touching the solder.

Carlos: OK. [gets up and goes to the dry-erase board at the front of the room] Let's let's make a statement of the problem.

Yiheng: (If the board is) flux.

Leon: Yeah, flux problem.

Yiheng: Flux.

Dai: So the board still wet.

Yiheng: Yeah.

Carlos: [speaking out loud as he writes at board behind Dai as Dai finishes his explanation to Yiheng] "solder balls"

Dai: So when it touching ( ).

Carlos: [drawing fishbone diagram on board, saying out loud the categories he lists as part of the diagram] So we have people, the system, the machine .. what more? People

Leon: Materials.

Carlos: the system. Material. [writes "Material."].Tools. [writes "Tools"]. Another one.

Juan: Profile and system the same?

Carlos: System, huh?

Juan: Profile the same, right?

Carlos: Oh, profile is for the machine.

Dai: ( )

Carlos: tool. and material. [walks over to where Dai's seated and checks team notebook for sample of fishbone diagram to see what category is left off] You and you have Before. Before we have [returns to board, writes "Method."] Before we have this this fish already. [pause] What what are the causes of solder balls? [points to back row as he asks the question.]

Leon: Too much

Yiheng: Too much

Leon: flux.

Carlos: too much flux pressure. Where shall we put it .. here.

Dai Method.

Leon: No, method.

Mr. Po: Method.

Carlos: Method.

Leon: Yeah.

Carlos: [says out loud as he writes] "Too much flux pressure." Uh we had the standard of ten cc per minute. [writes "STD 10. cc/min"]

Leon: Maybe nozzle problem?

Carlos: Nozzle problem? That's machine. [Says aloud as he writes] "nozzle of the spray fixture"

Leon: Or maybe the they don't uh apply the right uh profile?

Carlos: the right profile? And system. [says aloud as he writes] "Right profile" And uh the people?

Leon: Yeah, running too fast, right there. That's for the people, or?

Carlos: That would be uh

Leon: Is that the same thing uh right profile?

Carlos: [says out loud as he writes] "QC"? Uh,

Leon: Yeah, QC.

Carlos: "don't see the problem." [pause as he finishes writing] Uh operator, what more? [pause] Sir. Ernesto.

Ernesto: (inaudible)

[Dai makes notes, copying diagram off board]

Carlos: And uh

Macario: Proper speed of this uh proper speed of the conveyor?

Carlos: Uh huh. Conveyor speed incorrect. So it's a method, Mr. Po?

Mr. Po: Yeah.

Carlos: Incorrect. This is the same thing with the

Leon: Right profile.

Carlos: right profile. Um same. [Says as he writes] "incorrect conveyor speed."

Yiheng: Conveyor speed.

Carlos: Or um right profile if it's include like preheater, [begins to write "1. preheat" under "right profile" on "system" bone]

Leon: Low temperature?

Carlos: Too low. And uh

Yiheng: Sometime flux machine broken, is number only ten, only te- later twenty.

Carlos: Mhmm.

Yiheng: Yeah.

Carlos: So, uh, yeah it's pressure problem, too.

Leon: Nozzle problem.

Yiheng: Nozzle.

Carlos: Uh, spray problem. [writes "spray flux problem"]

Leon: [to Yiheng, and miming] That's why I I ask you to after passing the board? to the fluxer nozzle? Check-

Yiheng: I check, they are very good, later, later move later twenty

Leon: Maybe you maybe you forget. (laughs)

Yiheng: No, I ( ) you check it the same.

Carlos: What more? [pause] I think

Leon: That's enough.

Carlos: So we have we have identified the the cause of solder balls here. So can you understand the the the solution to this problem. 'K? We have the solution

Leon: We have solution already?

Carlos: One solution solution. [writes "sulotion"] Solution or suggestion.

Leon: Wrong spelling.

Carlos: Yeah [erases top of first "o" to make "sulution"]

Leon: You're that's that's

? S-O.

[Carlos redraws the "u" he just created out of an "o"]

Leon: S. S-O. S-O.

Juan: Solution.

Leon: No, S-O, S-O.

Juan: The first.

Carlos: Oh, yeah yeah. [changes first "u" to "o"]

Leon: Yeah.

Carlos: Thank you.

Yiheng: Solution?

Leon: Solution. "shun" "shun" "solution."

Carlos: So if you can base the solution with this kind of problem, right? First thing is use the right profile. [Says out loud as he writes in his "solution" column] "1. Use right profile." Number two?

Macario: QC. QC.

Carlos: 'K?

Leon: Don't know, maybe check the nozzle spray nozzle, you know? Fluxer nozzle?

Carlos: OK. [Writes "2. QC" then says aloud] "should check under"

Macario: Solder.

Carlos: "the microscope." 'Cause we cannot see solder balls. Sometimes they're too small, sometimes they're big, 'K? Uh, so right profile (incorporates (?)) with pre-heater, incorrect conveyor speed, and especially operator

Yiheng: check so small.

Carlos: [says out loud as he writes] "3. always consider first article." 'K? Before running production. Right? If there is any problem, if there's any problem, you see solder balls? operator and QC must let me know [as he says this aloud, writes "4. operator/QC must let tech know"]. OK? So to avoid solder balls we have at least four solution

Leon: solution

Carlos: right? [reading off board] Use the right profile, QC should check under the microscope, always consider first article, operator must let me know right away.

Yiheng: ( ) solution?

Carlos: OK?

Leon: No the solution for the

Yiheng: wave area.

Carlos: Thank you very much.

Juan: So the solution is follow the profile.

[Ernesto writes notes, copying diagram off board]

Carlos: Yep. That's right.

Juan: Just follow the profile.

Leon: [speaking to Yiheng while alternately pointing to list on board and miming the listed items] ( ) the profile. Check the profile?

Juan: Yeah. That's the better solution. Follow the profile.

Leon: Second, after wave? The board? Give it

Yiheng: QC?

Leon: No, give it to the QC?

Yiheng: Check.

Leon: Check, let her check with the microscope. And the third

Mr. Po: Also, we need to ( ) highlight the profile. The profile ( ).

Hoang: [As Mr. Po speaks, Hoang says something to Carlos about not checking the boards in the washing machine. Carlos responds with some comment about "last week."]

Dai: [pointing to the diagram on the board]. Everybody agree with the solution to the problem so we will (be back) for next Monday, know exactly what's going on. So is there any more question?

Carlos: If there's something Mr. Po will

Dai: Yes.

Carlos: talk before we you know uh before we before we end, Mr. Po have to talk.

Mr. Po: Yeah, I think this uh problem-solving like this solder ball thing very good is very good example. We need to put these kind of problem to make a highlight of the profile. OK. When we run this kind of board we need pay more attention so we run it the second time happen with same problem. So this solution very good. This is very good for everybody, we see how to solve the problem.

Dai: So we

Leon: So what's our next agenda the next meeting?

Yiheng: Next week again.

Leon: (laughs)

Dai: ( ) so see what's going on. Have any more problem, so what's the problem we got from here ( ) which boards are good or bad ( ) every Monday. 'Cause every Monday they have the meeting for quality. So Carlos ( ) let us know what kind of board ( ) tell us they complain so we check ( ) with the QC.

Carlos: OK?

Mr. Po: Next week we will have the ISO 9000 auditor.

Carlos: Uh huh, June 12.

Mr. Po: So everybody need to pay attention about the sometime, ESD, safety glasses, ( ), gloves, everything, the process and follow the

Carlos: And also maintenance maintenance log should always be signed before we go.

Mr. Po: Signed. Signed. You cannot ( ) drink cup and something

Dai: What day they coming Mr. Po.?

Carlos: Twelfth. June twelfth

Dai: Twelfth? Next week? So you never know what time they stop by. They might stop by any time. Actually, they stop by day time.

Mr. Po: No, some area

Carlos: No, sometimes in the afternoon.

Mr. Po: Never tell you.

Leon: They continue going around in the area?

[Dai makes note in book.]

Carlos: OK, meeting adjourned.

Leon: OK.

Yiheng: ‘K. Bye bye.

Leon: (laughs)

[all leave]

APPENDIX G: LINE-BY-LINE ANALYSIS
WAVE SOLDER TEAM MEETING

Line Number	Literate Activities	Functions	Documents Used	Participants	Description, New Codes, Questions
Wave Solder Team Meeting: Fishbone Diagram of Solder Ball Problem					
19	Carlos prompts Dai to read minutes of previous week's meeting	Referring A & B; Invoking a Rule or Script	Minutes	Carlos, Dai	Carlos's two-word comment is a recurrent reminder to Dai to start the meeting by reviewing the minutes of the previous week's meeting.
26-28	Begins to review minutes of previous meeting	Reporting	Minutes	Dai	announces that he'll "review last week" and begins to read/talk from notes in team binder
28-39	Refer to various assemblies	Citing A (MPI, Profiles, Assemblies)	Minutes	Dai, Carlos, Leon	discuss which assemblies still need fixtures
40-47	Resumes reading minutes of previous week's meeting	Reporting; Citing A (Daily Productivity & Quality Reports; Maintenance Log); Citing B (Manager's Complaints About Productivity & Quality)	Minutes	Dai	
48	Requests plan for meeting	Referring B; Invoking a Rule or Script	(Agenda)	Carlos	refers to organizing document which, in this case, doesn't exist
49	Conjures up an agenda	Referring B	(Agenda)	Dai	
53,57	Refers to stable productivity trend	Citing A (Weekly Productivity Report)	(Productivity Report)	Dai	
54,56	Jokes about own productivity	Irony		Leon	Leon appropriates official language of the plant for what is both self-effacing humor and a critique of company expectations (e.g., as represented in standard times)
88	Refers to particular assembly	Citing A (MPI, Profile, Assembly)	(MPI) (Profile) (Assembly)	Dai	
90-92	Invokes the Rule of Universal Fixtures	Invoking a Rule	(MPI? MOP?)	Dai	reminds Leon to use universal fixtures when no other fixture is specified, that engineers won't allow boards to be waved without fixtures

APPENDIX G: LINE-BY-LINE ANALYSIS
WAVE SOLDER TEAM MEETING

Line Number	Literate Activities	Functions	Documents Used	Participants	Description, New Codes, Questions
93	Asks for clarification	Requesting Clarification	(MPI? MOP?)	Leon	wants to make sure he's right in thinking there's no fixture for a particular assembly
94-97	Explains proper procedure and the reasons for following it	Explaining; Citing B (adjusting machine)	(MPI? MOP?) (Machine Settings)	Dai	explains the Rule of Universal Fixtures
98-101	Explains reason for not following procedure	Explaining	(MPI? MOP?)	Leon	explains reasons for circumventing the Rule of Universal Fixtures
113-115	Explains problems encountered even when following proper procedure	Justifying; Citing B (QC inspection)	(Assemblies)	Leon	
126-134	Refer to customer feedback on particular assemblies	Citing A (Quality Report; MPI, Profile, Assembly); Citing B (Weekly Quality Meeting)	Quality Report	Carlos, Leon, Yiheng	Carlos relays customer concern about recurring problem (solder balls)
135-136	Requests report	Requesting Documentation	Quality Report	Carlos	asks Dai if he has Quality Report
136, 141	Locates document	Locating	Quality Report	Dai	finds document and gives it to Carlos
137	Takes a stab at the cause of a problem	Conjecturing; Citing B (changing profile)	(Profile)	Dai	
139-140	Refers to assemblies listed in quality report	Citing A (assemblies; quality report)	(Assemblies)	Carlos	
142-148	Refers to meeting; refers to and reads document; offers document as evidence of problem	Citing B (quality meeting); Referencing; Explaining	(Quality Report)	Carlos	
149	Look over document	Perusing	Quality Report	Leon, Yiheng	Leon and Yiheng peruse document as Carlos offers a course of action and finishes his explanation of the problem
150-152	Suggests course of action and explains one possible cause of problem	Problem-solving; Explaining; Citing A (Assemblies); Citing B (Machine Settings)	(Process) (Assemblies) (Machine Settings)	Carlos	explains importance of proper settings for flux spray and conveyor speed; explains the relation of one setting to another in the larger process

APPENDIX G: LINE-BY-LINE ANALYSIS
WAVE SOLDER TEAM MEETING

Line Number	Literate Activities	Functions	Documents Used	Participants	Description, New Codes, Questions
153-163	Let fly a flurry of conjecture	Conjecturing (conveyor speed, pressure setting)	(Machine Settings)	Yiheng, Dai, Leon	
157	Articulates one sign in order to make sense of another	Signifying	Quality Report; (Assembly)	Yiheng	provides a physical description of a particular assembly that's conjured up when he reads the assembly number
160, 164-169	Explains customer feedback process; Gestures to illustrate unstable manufacturing process; Suggests course of action	Miming; Citing A (Assemblies; Machine Settings); Citing B (Meeting with Customer to Give and Review Feedback)	(Customer Meeting) (Quality Meeting) (Weekly Quality Data) (Assemblies) (Machine Settings)	Carlos	explains problem, gesturing to indicate dramatic peaks and valleys in a graph, illustrating history of problem and effect of customer feedback.
174-175	Requests and reads documentation	Requesting Documentation; Perusing	Quality Report	Hoang	
177, 179	Suggests closer and more frequent scrutiny of boards and appropriate adjustments to machine	Citing B (reading assemblies; adjusting settings)	(Assemblies) (Machine Settings)	Leon	
180-189	Discuss quantity of boards affected	Citing A (quality reports)	(Quality Reports)	Yiheng, Leon, Carlos	
193-196	Suggests closer scrutiny of boards and appropriate adjustments to machine	Miming; Conjecturing; Citing B (reading assemblies; adjusting settings)	(Assemblies) (Machine Settings)	Leon, Yiheng	Leon mimes the reading of a board as he suggests to Yiheng that he check boards carefully and make appropriate adjustments in machine settings
197-198, 203-204	Proposes a particular format for identifying causes of problem	Proposing B	(Fishbone Diagram)	Carlos	
199-212	Assesses an understanding of a possible connection between machine settings and a problem; Explains that connection	Assessing; Explaining; Citing B (adjusting settings)	(Machine Settings)	Dai	

APPENDIX G: LINE-BY-LINE ANALYSIS
WAVE SOLDER TEAM MEETING

Line Number	Literate Activities	Functions	Documents Used	Participants	Description, New Codes, Questions
210, 213-278	Brainstorm possible causes of problem	Brainstorming; Coaching; Gaining Consensus; Clarifying; Referencing; Citing A (Machine Settings) (Profile); Citing B (Adjusting Settings; Reading Board)	(Machine Settings) (Profile) (Assemblies)	Carlos, Leon, Jose, Dai, Yiheng, Mr. Po, Ernesto, Macario	Brainstorming process here includes clarification of proper categories for idea offered (217-220, 230-325, 244-246, 255-264), referencing (222-225), Citings B (references throughout), copying (252), coaching...
279-280	Summarizes their brainstorming process	Summarizing	List on Board	Carlos	
282-294	Proofread and correct spelling	Proofreading; Correcting	List on Board	Leon, Carlos, Jose	
295-296	Aids team member in pronouncing written word	Providing Linguistic Assistance	List on Board	Leon, Yiheng	
297-298	Invokes a rule for forming solutions from problem statements	Invoking a Rule and Script	List on Board	Carlos	
298-312	Brainstorm possible solutions	Brainstorming; Citing A (Profile; Machine Settings; Assemblies)	(Profile) (Assemblies) (Machine Settings)	Carlos, Leon, Macario, Yiheng	
312-316	Summarizes solutions listed on board	Summarizing	Lists on board	Carlos	
322, 324-325, 328	Highlights the importance of following the profile	Highlighting	Lists on board; (Profile)	Jose	
323	Copies diagram off board	Copying	List on board	Ernesto	
326-333	Assists in understanding the solutions listed on the board	Coaching; Miming	Lists on board	Leon, Yiheng	
334	Highlights the importance of the profile	Highlighting	Lists on board; (Profile)	Mr. Po	
337-339	Asks if group agrees on solutions listed on board	Referencing A	Lists on board	Dai	

APPENDIX G: LINE-BY-LINE ANALYSIS
WAVE SOLDER TEAM MEETING

Line Number	Literate Activities	Functions	Documents Used	Participants	Description, New Codes, Questions
343-347	Declares the group's process good; Highlights profile	Bestowing Blessings; Highlighting; Citing B (problem-solving process)	Lists on board; (Profile) (Assemblies)	Mr. Po	Mr. Po puts his stamp of approval on the group's problem-solving process and again highlights one particular solution
352-355	Refer to future agenda and to future activities which will determine next agenda	Citing A (Agenda); Citing B (Quality Meeting); Planning	(Quality Meetings) (Quality Reports)	Leon; Dai	
357-370	Refers to ISO audit & auditor	Citing B (Audit; Signing Maintenance Log; Following Procedures)	(MOP's) (Maintenance Log) (MPI's) (5 S's)	Mr. Po, Carlos, Leon, Dai	
359-362	Admonishes the team about particular procedural violations	Admonishing	(MOP's, MPI's)	Mr. Po, Carlos	
371	Makes notes of meeting's proceedings	Recording	Minutes	Dai	

APPENDIX H: COMPLETE TRANSCRIPT
OBSOLETE DOCUMENTS EVENT

Maggie & MJ are talking in Maggie's office. Eduardo appears at the door, board in hand.

M [to Eduardo] Hi. Come on in.

E [to MJ] How are you today?

MJ Pretty good. How are you?

E Fine.

MJ You're looking cheerful.

M He hasn't even had a- [laugh] He's looking cheerful. He always looks cheerful. What can I do for you?

E About this, ahh..., HP board?

M The who? Oh that, uh, cute little thing?

E Mm hmm.

M Yes, uh huh. What about it?

[Maggie is seated behind her desk. Eduardo comes around and kneels beside her, sets the board on the desk, and spreads the MPI on the desk for them both to look at. During the following talk, they look alternately at the board and the drawings. Sounds of pages being flipped.]

E On the drawing you have to put the part on like this, but on the kit, or maybe this is a substitute part for this one.

M Have we done this board before? It looks familiar.

E Day shift, day shift did this one before. We just did, what we did, we just put the uh screws on.

M Uh huh.

E [indicating written instructions] See, "As per drawing, the CR one..."

M No, let's go this way. [shifts drawing around]

E CR one and uh this one is Q six?

M Yes.

E Should be, should be this same kind like this one, but now we put [END SIDE A]

[While MJ flips tape, Eduardo indicates that the drawing indicates both CR one and Q six as an oblong component, all exposed metal, including a round pad in the middle into which another component fits. This second component is to be grounded to the oblong. On the current board, however, the oblong components have been masked, or covered over, leaving no exposed metal except for a small round rivet at the end of the oblong. The component that fits into the center pad of the oblong can no longer be grounded to the oblong itself, as on the older board, but must be grounded to this rivet. This requires a longer ground lead than was necessary on the old board. Eduardo has discovered that the leads on the components in the new kit aren't long enough to reach the grounding rivet.]

M Uh, this lead here or what's, what's short, Hon?

E Because on the board, on the board we have to solder on this land- on this pad?

M Oh, you're kidding?

E I'm not kidding. But-

M I- I believe you.

E I just, I just take a look at the board, because the board is, the board is in the, is in the SMO lab. And I ask hi-

M Is where?

E SMO lab.

M Uh huh. Oh, okay.

E It is plug into their system there, I ask the guy, William? And he said just, just leave it there the board. Because the board is, there is a tag that, customer sample?

M Mm hmm.

E I just take a look uh real quick look,

M Uh huh.

E what is the orientation of this one and this one also. But this one, I didn't know that this part should be short like that.

M And their, and their sample upstairs in SMO is using this part?

E Mm hmm. Yeah.

M Instead of one of these?

E Uh huh. This two guys here

M Uh huh.

E and there's a, they put the solder on the side, solder. I ask Wade, but uh Wade, I don't know, was going...[starts to smile]

M He was in a hurry to leave. [rolls her eyes]

E In a hurry... I ask him... [laughs] Oh, my god.

MJ [laughs]

M And this is an HP board, right?

E Uh huh.

M And Wade's the HP man.

E And he just told me what kind of wire we're gonna put in. I ask him, "Bus bar?" "No," he say soldered wire from prepping area, what kind of... from thi-, from uh, from the uh, one of the, uh, no, wires from the resistor, they discarded them?

M Yeah, uh-huh. Extra leads?

E Extra leads, and that's (how we'll) put in, but he said that much. And he

M This much? Yeah.

E Yeah. But I want, I want to see the sample, but sample is inside the SMO lab.

M And, uh, what, it's hooked,

E Plug in. Plug in.

M it's hooked up?

E Yeah.

M Hmm. And is this, uh... do they want this part uh

E Standing up like that.

M straight? Standing up?

E Yeah. Standing up like that. But I didn't see if this the uh this the middle leg should be up a little bit. Because it's go like this, it's plug like this.

M Uh huh.

E And there's solder on this, this end. I don't know how much. Maybe they put the wire that long and then put solder on, lap solder on this lead. Lap solder and then connect the lead.

M Mm hmm. 'Cause if you bent that leg up a little bit more, it still wouldn't get any, it wouldn't get any longer.

E Still it wouldn't get any longer, still… Did the last time, most of the time day shift did this one, did this one. And the last we did this, just put on the hardwares on the screws.

M What, on these, on these particular ones?

E Uh huh. Seven sets of screws.

M Well, that's what, yeah... I'm sure he suggested using uh uh leads from prepping. Either that or you can also use this lead here.

E No, he said a solid, a solid uh lead.

M This is solid.

E I don't know what kind of solid lead.

M Yeah.

E See he didn't mention to me about that or

M Well this is solid also but all you gotta do is just, you know, is either… is this the top si-? OK. It doesn't have a pad on the top, so you you can only solder it from the bottom. Solder it from the bottom, clip the lead, and then use the lead what you're clipping and lap solder it to here. And it's flat also. [.04] That's what I would do. [.06] What do you think?

E Because when I brought down this, uh, this, came down, you know, just take a little bit more there, just bend this one without knowing that this one is short like this one. But I didn't see that this one should be straight like this. So, if [.08] if this one should be touching the board or, up a little bit

M Well, it sits right there on the shoulder. I mean that leads not gonna go any farther in the hole even if you have this off of the board, right? Let's look. Let's bend this forward a little bit.

E I just, I just bent it by myself like that a little bit, without how long it gotta be bent

M Mm hmm.

E Like for example, this one? You have to bend a little more than, more than the shoulder because if you let go inside you have to (line) on the board to put these screws on.

M Where is it? Is it going to drop past the shoulder anyway? No. Huh uh, it's not going farther than that anyway. [.04] There you go. Now you don't have to do anything. [.03] I mean what's wrong with the board sitting in this tilt position? Then you don't have to do a lap solder lead. You have a better reliable uh solder joint by using the uh...

E Except for cutting one piece and lap soldering it?

M Uh-hmmm, right. That's even a better idea. Then it's definitely more secure. [.05] Or if you feel uh if we if you feel strange about it being tilted, is that any...

E Maybe, maybe bend this one a little bit...

M or, uh, yeah, give it a uh...

E How about a short bend, a short bend on?

M Uh hmmm. Like this.

E Look like a smooth curve like that.

M Uh hmm. [.05] Something like that, and it's still, you still have enough lead, or even a...

E Instead of connecting a...

M Uh hmm. Or we can still, instead of bending it at the shoulder... [.08] Oops, too far down. [.08] That bend's getting turns- turned more and more, huh? And it's not touching the board and it's still a solid solder joint on the uh pad. Or like, OK, right back to the same thing, if you want it straight ,huh?

E That lead? This one is straight, is straight.

M 'K, hold that straight, then what do you got? It's still solid. You still got solid, and you don't have to uh do a lap solder, instead of where it was at way back here.

E You can do that but, uhh, tomorrow Wade suggest we do lap solder just we do like this one or

M We have a better reliable board than he, his comment, though.

E But

M No. Nuh uh.

E I think this one, it'll be OK, right? but

M I think this one's better.

E the sample- Yeah, this one's better, but the sample board is, I don't know how, how to, I'm not, I'm not quite sure how to bend this one, like this one or just bend straight and making it ninety degrees

M Yeah, 'cause I really don't think it matters at all how this is bent. You know, you've got your solder connection on this, uhh, you know, your, uhh, (admiter) base and collector of the uh transistor. I means it's, it's ... and this is your ground. I guess this, yeah, this's gotta be ground. [.03] This is better, this is a more reliable solder joint

E Uh hmm. I agree with you.

M than uh than his. And with the other way, when you're lapping that uh lead onto here, and and lay it on the board... I don't like lap solder. Lap solder, to me, is not reliable. A hook, is is best. But a lap solder? No. Let's go ahead and either give it a bend and flatten it out, I mean, that that looks good, even your, uh, even your transistor. You call this a transistor or you call it a regular, which one do they call it here? Transistor? No, they call it a diode. Huh?

E Diode.

M Huh?

E I think CR one is a diode.

M Hmm... that's a diode? To me that used to be a transistor, but things do change. So what do you think? You feel comfortable on that?

E This one should be, should be little better than putting a lap solder on the-

M It's faster, too.

E piece of clippings from a uh prepping

M Uh hmm. Well, yeah. It's faster, and it's more reliable. Try one and uh and and see what you think how sturdy it is. You're gonna hafta, it's gonna hafta take a lot of solder. I mean a lot of heat to uh heat up that ground one way or the other, and if you take it off, it's gonna take a lotta heat, you're lap solder lead will end up heating up and uh and uh coming apart. Possible. [.05] And the uh sample that's upstairs in the SMO? is that the way that the uh diode is uh facing?

E That's what uh I look at it when I came up there.

M And did you uh show that to Eduardo? I mean to Wade? Did you already have the diode in there.

E Yeah, I showed it to her- to him, like this one. Because I bent it, I bent it not that it is exactly like that, and I told him it's it quite short. But I'm not, on that particular on the bend itself upstairs on the board on the sample board, but I just try to bend by myself, and I figure out it's quite short on this side, if it's short then you have to put lap-solder on a piece of, short piece of

M Right and he was in too much of a hurry to stop and spend a few, a few minutes...

E If he's in a hurry, he's in a hurry, maybe just go upstairs and try or get the

M Yeah because he left here at uhh, twenty minutes to five, saying that he had to leave and go pick up his car from being in a repair shop, or whatever. I would I would do it that way. It's faster, easier, more reliable. Better looking. [.09] And I don't think that I don't see that Wade should have a problem with that, 'specially if we had enough initiative and ingenuity to to look at the parts and be able to use one piece instead of lapping a uh a lead over it instead.

[.05]

E Wish I know why they change- the uh deficiency of this uh drawing is they have this kind of part and now they change with this one and then…

M Well, that's the problem 'cause it's an HP drawing, they haven't updated their drawing. And, uh

E Like for example this one? I just take a look at the boar- the part is gone. Oh, they cut the- [sound of pages being turned]

M Is that what we're using, the MPI, is saying it goes in there?

E Nothing.

M Hm?

E Nothing.

M It doesn't say?

E Doesn't say, doesn't say anything. [laughs]

M Doesn't say anything in second ops?

E That's what I I

M What, everything is here?

E Uh hmm.

M For the, for the, for the board?

E Uh hmm. That's the deficiency of most Wade's uh

M I know, slim and none, huh. [reading from MPI] "Install in solder components per notes three and four on assembly drawing." Good ol' Wade.

E [rapidly] Three and four is like this, but you know the part that we're putting on is different from what different from the drawings, so I think it has to go upstairs in SMO because because this board, you know, is going SMO anyway, maybe they have the board there. Watch the board, it happens that they have the board but it is plugged in a system, so I ask the guy, William, if I can take this one, but he said, "You better ask Jack Sutton," oh, my god.

MJ [laughs]

M Uh huh. [reading from MPI] "Install Q six, seven, twelve, and thirteen with mounting hardware after solder flow." After solder flow... [.06] hmmm. "See detail A. Add CR one after solder flow."

E I guess the last time we di- day shift did this one-

M Oh, okay.

E day shift did this one

M After solder flow. Mm hmm.

E they put on this one and then they just put the hardware on these two. See, but that's the deficiency, they've been putting on the different part, and see this one, now no detail of this one should be cut in the middle, this one should be bent like this. That's what I'm saying. "Just follow the drawing," but this much different.

M Yeah, the draw- the drawing is definitely wrong. And how old is this MPI? [Reading a date on the MPI] "Four twenty-six ninety-four update BOM." This is eight thirteen when they initially released this to manufacturing.

E The drawing says nineteen seventy-nine.

M [laughs] Bingo! See, this, ...

E The thing, you know, sometimes Maggie

M this should never-

E that makes me, you know, I don't know how could, you know, if we want to work uh (...) on this board, but you know, we're (...) but the MPI is not clear, so we have to talk to the, with the engineer, but the engineer's running to [laughs]

M running home

E running home to you know I don't know

M to pick up their wife and their car and... [flips through MPI, looking for BOM] And uh, CR-one... CR-one... so is there a, see, it is a transistor. This says two-M. It's calling out CR-one.

E Yeah, yeah, should be that part. Yeah.

M And it's calling out two-M.

E CR-one is now two-M

M Two-M is a transistor, in my lifetime. A diode is a one-M. No, one-M? Two-M? No, no, yeah, yeah, you're right.

E Looks like, Maggie, look, look, Maggie, like Eldeck? Look like the Eldeck? Diode, diode is CR-one, CR-two, same as the Eldeck, so they're, may be from the same, uh huh.

M So is this the part number that we have out there?

E Yes.

M This part number?

E Uh huh. Yeah.

M And it says here that they've updated the BOM as of four twenty-six ninety-four.

E Yeah, some day there's a notation here from, I don't know, some place or whatever

M "Add per ECN sixteen eighty-nine." Hmm. Rod Schlick. "Delete per ECN, sixteen eighty-nine." 's, labels and warning labels, and laser print and whatever. Date code, manual, whatever, identification, so these must be the labels that they have eliminated and now they've got. So that was the only new, uh, new information in this, on that BOM. Yeah, we definitely need to make a note to uh to Wade.

E So what we gonna do then with this one Maggie? Just go ahead and put this four items and then-?

M No, do them all.

E Do them all?

M Ah ha. Do it all.

E Like, like this one?

M If you said that you've got the part per the BOM, that's the part number that's on the BOM

E Mm hmm.

M ah, then do it. Um hm. [still looking through MPI] See, these are, 'cause I don't know if Rod Schlick is still here or not. Because, I think, what is he? Is he the ah, program manager? Of course, he wouldn't know anything about, uh… I wouldn't think. He's pretty smart, though. Let's see if Rod Schlick- Schott's here. See if he can come down and look at what we wanna do. Line's busy, that means that he's still here, huh.

E [to MJ, referring to what he thinks he saw when he took a quick look at the board earlier in the day in the SMO lab] I hope my eyes serves me right when I look at this part. When I go up... Because the board is plug in like this [indicates the board standing on end]

M [on the intercom, which drowns out Eduardo's comments to MJ about what he thinks he saw in the SMO lab] Rod Schott, please call six one four five. Rod Schott, please call six one four five.

E [reaches into the pocket of his smock and pulls out a few scraps of paper on which he's made quick drawings and notations] Just got some pieces of paper and just did like this. Looking at the sample boards..

MJ Um hmm. So you've made a little note? ___

E I made a little note, just a little, because I can't get the board out of the-

MJ Is this your whole.. .you've got a whole bunch of this stuff, then, huh? This kinda keeps you organized?

E It's just like a big (…).

M Keeps his own self organized. I don't know about these notes.

(all laugh)

M He's as bad, he's as bad as I am.

MJ Yeah. I, it's great.

M Or as good as I am. I told you he's supervisor material.

MJ That's right. So what, what did you write down?

E The orientation. See this one? [pointing to his drawings] The orientation for, for CR-ones should be standing up, standing up like this?

MJ Mm hmm.

E And then solder on that side. Solder that side. That's why, the way I look at the board, because it's plugged in like this.

MJ OK.

E Standing up like this. And the solder on the two, on the two legs, and then (…) solder on the side, and this one should be, should be laid flat. Just put a screw there, and then tuck this in the middle, then solder on both sides, left and right. But this one-

M (laughs)

MJ This is good. Eduardo's, Eduardo's MPI, right here, huh?

M That's his shorthand!

MJ Yeah. I like that.

E But I try to figure out, because the board's

M I love it.

E because the board is right there, plugged in, in the system

MJ And they won't let you take it down.

E They won't let you take it out. And the drawing is-

M The drawing is obsolete.

E I just try to be resourceful, you know, out out of the blue, that

MJ Right. That's great. Can I, and I'm- you're so resourceful, I'm going to ask you for a copy of that before I go home.

E [laughs]

MJ Seriously. Maggie -

M A copy of that little note?

MJ Yeah, that little note. Yeah.

E I just copied some--

MJ Maggie knows how I am about writing.

E Oh, he's, yeah, he's, he's

E [rapidly recounting the written portion of his notes] Actually 'cause Pong- Pong Chi just give me this assembly number and then said " Just go out and do this side," OK I just try to figure out the part, the part numbers, or we just check it out on the kit, the part numbers because finally on this.

M I want to know if you had to read that note tomorrow, would you still understand what you wrote?

E Yes, of course.

M I love it.

E Of course.

M I love it. [laughs, picks up phone, tries Rod Schott again]

MJ Hm.

M Still on the phone. [hangs up]

MJ [looking at board with Eduardo] I mean, that's such a dramatic change,

E Yeah, really.

MJ that it's interesting that it's not marked on there.

E Yeah, I showed before, I showed before to you that most of Wade's, you know,

M (laughs)

E projects, MPIs not updated, and handwritten, but it should not be. It's against manufacturing operation- operating procedure, da-da-da da-da-da, something like that, that you don't have to make if official, you don't have to put handwritten notes.

MJ Yeah.

E But, they let it go like that, they want to happen like that, you just have to be an ME to

M Which one are you talking about?

E No, some of the MPI's, they just put an update in it, and then

M Oh, yeah, exactly what uh

E It should not be, it should not be like that, if you are, if you want

M what Wade O'Malley is very well known for

E Very well known for that.

M for ah... for ah "installing solder components per ah notes three and four on assembly drawing." And and and he's done. (phone rings) Ah ha! There he is. (answers the phone) Maggie speaking. Yes! Rodald! Yeah, you're still here! Well, I knew that the line was busy, so I figured that you were on the phone with a customer. Um, SMO, what is it? Grilly? Gridly board? Or, Greely?

E Yeah.

M Yes, are you familiar with this board at all? [.03] Ah ha, forty-two-oh-seventy-two, right. [.02] Good, I know. [.02] Yeah, do you have a few minutes to come downstairs and look at the MPI and what we need to do on this board, which uh does not conform to the assembly drawing. [.05] Trust me. Will you? Back stairs? Okay. Meet you out there. 'kay, bye-bye. (hangs up phone) He said, "I can't imagine why it's not conforming to the MPI." Trust me! (Laughs.)

MJ (Laughs)

M [to MJ, handing him a grounding heel strap] Here put this on your

E Better if he could, ah, open up the SMO lab there, I don't know.

MJ (laughs)

M Well, maybe we could sweet talk him.

[Maggie, Eduardo and MJ leave Maggie's office and walk out onto the manufacturing floor, to the hardware area where they wait for Rod Schott.]

E I mean, I just…

MJ Yeah, it really handcuffs you, doesn't it, on what?

E Really a hold-up.

MJ I mean you're...

M Yeah, and there are only thirty-six of them to do, and it could have been done by now, huh? Huh? (Laughs) Hey, you did the right thing. It was probably the right thing to do

E That's why when you were talking with Wade and Vivian, I mentioned to you that I had a question for Wade

M Yeah...

E and you were talking with him at that time then he go, those two guys, Frank Newhart and the other guy, then I just called him, "Wade, Wade, wait for a second," and he was, "Very quick, just going out.

M Oh, and he was, yeah because when he left here, and finished with me, after we finished in my office, then he said he had to uh leave and go pick up his car, then when I came out he was over here chit chatting.

E He talked for a while with Frank uh Frank Newhart and the other guy...

M then he left, huh.

E The other engineer, Scott Allen...

M Scott Allen and Frank Newhart. Okay. He said he was going to hurry right down here. Hm. Hm.

MJ There he is.

M There he is. Hello!

RS [Rod Schott appears with large, red three-ring binder under his arm] Hi there!

M How are you?

RS Do I get my second shift?

M Well, I know that you are still here, I see you at eight o'clock every night.

RS I'm on first shift too, but I'm not telling.

M Well, I like it. Maybe you can ah, give us some directions here, or we can tell you what we have. Which would you like to hear first?

RS You tell me what you're doing?

M OK.

R I don't know that much about

M You know Eduardo, though. You know Eduardo?

RS Yeah.

M Okay, Eddie, do you want to tell Rod, or do you want me to? Go ahead, go for it.

[Eduardo sets MPI folder on workbench, opens it up, and he and Rod bends over it, scanning it as Eduardo begins to explain the problem.]

E Well, as per the drawing should be like this one, and right now the kit, we're getting this kind of part. This part here, and this one. And from the uh the instructions in second ops should be, Touch up, after touch up, "install and solder components per notes three and four." [turns to drawing]So notes three should be like this one this, "Install Q six, Q seven, Q twelve, Q thirteen."

RS Mm hmm.

E "Mounting hardware after solder flow. See detail A." So this is Detail A.

RS Mm hmm.

E Put on the ah, part, then this screws on, and then the washer, split washer, and then the nut. But this two locations, this one and then the other one, should be this kind of part, but we're getting this kind. [.03] What I'm saying is, this kind, per the drawing

RS Yes, yes.

E should be this kind, and also (…) like this.

RS Yeah, and uh I think I know what this is about but, what's, what's the part number on this thing, do you know?

M Mm hmm. Oh, he's got his notes. [indicates Eduardo's scraps of paper] (laughs)

E What part ? That one? One eight eighty-four dash oh two four nine.

RS [opens large red binder, refers to ECNs and BOMs.] Yeah, this is what it should be.

E One eight eighty-four dash

RS oh two?

E oh two four nine.

RS [Leafing through pages] OK, let's see if I have anything in writing on this. [.09 pause as RS looks through book. In background, can hear Maggie and Eduardo confirming part number] 'Cause I believe this is the one that uh we got an authorization from, uh…yeah. We used like the sample board. Um, do you know where the sample board is?

E It's in the SMO lab, but it's uh plugged in to system. I want to get that board for a sample for us here to look at, but it is plugged in, and it look like a customer sample?

RS Mm hmm.

E Inside the SMO lab.

RS Yeah. Is it locked?

E It's locked now.

RS It's locked now, but we could probably get to it if we needed to.

M Yep.

E You could get it if

RS [Again referring to papers in big red binder.] This is the one. This is the one, 'cause ah the engineer had already designated this.

M Wade O'Malley. Uh huh.

RS Right. Ah,

E How about the other one, Q six is eighteen fifty-three dash oh six five two.

RS What I am wondering about is...

M oh six five two is on the same MT

E Same MT

M All right Eddie!

RS Is there any deviation or anything?

M No sir, no sir.

E Just the BOM update and (…)

RS Oh, those are, those are from before. Okay. BOM. [flipping through MPI]

E Lookit, no deviations so far.

RS OK.

M Heh heh heh.

RS Let me see what I can find. If if we had the sample board...?

E Yes. It's right inside the SMO lab, if you could get it, we would appreciate it very much.

RS Would that be enough?

M Well, Eduardo went upstairs and he looked at the sample board, so in case, you know, so you don't have to make a special trip.

RS Right.

M Eddie went upstairs and looked at the sample board and the uh diode is standing in this position with the lead on the uh on the uh ground here. He showed, he showed that quickly to Wade O'Malley.

RS Mm hmm.

M And Wade said, you know, "Take a lead from a a prepped part and lap solder it onto here." Because originally Eddie had this bent down to match the other shoulders. Of the lead here?

RS Mm hmm.

M Okay, so the lead was only coming to the end of the ah, ground here. And Wade says, "Well, get another lead and lap solder it next to this lead, and solder it on." We did a pre-form and changed the layout of it, and this is what we can do

RS So now it's on there pretty good.

M without lap soldering a lead on there, and just a straight ground,

RS Right.

M right, you know, right to there. Because he went up and already saw the sample board. If you want to bring us the sample board, you know, you can, if you can get it, but Eddie's already looked at the

E But still I want to take a look one more time just to

RS Yeah.

E Just to make sure, to really

M To make sure

E to make sure.

RS Okay.

E If we will not be able to bring it down, maybe just go up and take a look one more time.

RS Well, if I can get in, I'll bring it down, that's

M Well, I can go to the security and have him.

RS Well, that's what I was going to do. That's what I would do.

M So you can go and relieve him, and he can go upstairs and ah, unlock the SMO lab for you.

RS Yeah. And you know exactly where the board is

E Yeah, it is inside the other room.

RS Well, let's just do that for starters and then the other thing that I'll try to do, is I have a bunch of stuff on my desk that I haven't filed into my book yet, and I may have the letter from HP that says to do this. I think I have a copy of that, but I don't see it here.

M Uh huh. Okay. So you want me to go to security and, so he can relieve you to unlock the door, or you want to go to your office first.

RS Well, if we get the sample, you can start

M Right.

RS the work, right?

M Right.

RS Let's, let's do that.

M Okay. Do you want to go with him, Mark?

MJ Sure.

M Okay, I'll go to security.

MJ [to Rod Schott] I'm Mark Jury.

M [to Rod Schott] Oh, Mark Jury,

MJ I'm from UC Berkeley? Working with Kathy Schultz and the others.

M UC Berkeley

RS Oh, okay. I knew you looked familiar, I was trying to figure out...

MJ I'll just go up, I've been floating around for months.

M For months and months.

MJ So if I'm stooping over you like a vulture, that's why.

RS No, the thing that I was wondering about is ah, the (BABT)

M Oh, the (Babbit)?

RS Right

M Uh huh.

RS The thing that was going through, and I was thinking, okay, is he examining every last...

M Oh no! I'm sorry,

MJ No, no.

M that's my fault that I didn't introduce you right away.

MJ No, what I am mostly interested in is the communication and the oral and written kind of interplay, and how when problems come up, how people solve those problems, using both the written, the schematic, the oral communication, that kind of stuff.

M And we just happened to be...

MJ Yeah. So this is, I am always thankful for problems.

M Are you going that way?

RS Yeah, who's going to security?

M I am going to security.

RS Okay, and he is going to come up there and unlock it, well, we'll just go up there and wait.

M Ah ha, right. And that is in the cage area, and you have to got through he door? And you got through John ah...

E The case are, there is a door there that you have to go inside.

RS Yeah, but I was going to be out in the hallway by the xerox machine.

M Oh, okay. I'll send him up that way then.

RS Well, that's where the door is.

E But there is a door the other side near the office near the SMO personal logging. There is a SMO personal logging, there is a door there that maybe could be opened up.

RS By the xerox, the one upstairs in the office.

E Yeah.

RS Well, that's where I am going.

M Okay.

RS All right.

[Maggie leaves for the security station; Eddie, Rod and MJ walk upstairs to the SMO lab]

E (I hope my eyesight's the right thing)

MJ [Laughs.] You're afraid your eyesight's failing?

E I'm thinking about the other things. About the things I have to do, the first priority, second priority, just want to be done.

MJ Yeah. There's not many of these boards, huh?

RS So are you on the night shift here, then?

MJ Yeah, yeah. I get the special duty.

RS Oh.

MJ I've been, what since, October, Eddie? I think?

E I think.

MJ Off and on. It is kind of a nice crew of people to be with, though.

RS Yeah, things are a little quieter at night, although

MJ Yeah

RS when she paged me I was still on the phone with one of my customers. They'll call me all the way up to seven or seven thirty at night. I can't get anything done.

MJ Oh, really, wow.

RS It's terrible. I mean it's nice to have the customers,

MJ Yeah, (laughs)

RS but the work is overwhelming. Absolutely overwhelming.

MJ Does that go in waves?

RS Nope.

MJ Nope? It's just kind of constant.

RS [outside the door to the SMO lab] Yeah. I used to have a key to this, I gave it to somebody. Maybe Jack Sutton. There were times when I wished I had it. Well, it seems for downstairs, the caged areas downstairs, I can't get into at night. I can go through to go into the back, but I can't get inside like RI and some of those areas.

Everybody goes home at five o'clock and I'm still here at seven or eight trying to get things done, and I just, the night shift is just awkward.

E What is the thing you do (About that)? What time...

RS Oh, eight thirty, usually

MJ That's a pretty long day.

E It's a long day for me everyday.

RS A long day

MJ Yeah.

RS And I don't even hardly get to eat my lunch. Today I started at ten after twelve, ate a few bites. I finished my lunch a two o'clock.

MJ (laughs)

RS No actually I never did finish, I put the rest of it in...

MJ (laughs) What's the SMO lab?

RS SMO is Support Materials Organization. That's Hewlett Packard, and they're up in Roseville. And this lab is almost entirely dedicated to the products that we build for them, which is about twenty-eight different products from four different transfers. What they're doing is um, when one of their products goes out of production, and they still have what they call post production manufacturing, and it goes into like a support phase, so these are like spare parts that we are building for products that they are supporting out in the field.

MJ Oh, I see.

RS So, something that we built, for example, for a lot of these things in here is from Singapore, and they took it off of their lines at Singapore,

MJ Uh huh

RS They transferred all the production and test equipment to us.

MJ Okay.

RS So we call that a transfer, you know, the Singapore transfer,

MJ Right

RS So that, so now we are building five different assemblies on the Singapore line, and then we've got, Greely is one of them, which is kind of a lower runner, in terms of volume, and Boise, Color- uh Boise, Idaho, and then San Diego.

MJ Hm. So, these are things they don't even make anymore, but still people are using them, and either they if they want them updated or repaired? Is that...?

RS Yeah. It's for, like the Singapore stuff is like a calculator. It has all kinds of special features on it. I don't really understand why they're so great or whatever, but

MJ Yeah, somebody likes them.

RS They are for navigation, and they've got some real unique things. You can print from them, and all kinds of stuff. So, um, geez, I wonder what happened to him?

MJ There we go

RS So anyway,

MJ There we go

RS it's that on the Singapore stuff, on the Greely stuff, it's ah, these big...

drives

[security guard]

S Hi guys.

MJ How are you doing?

S Fine.

RS Boise's got some old hard disks that are these big floor mounters.

MJ (laughs)

RS You know, twenty megabytes in something that's five hundred pounds, you know, you could never even pick up. And then, ah, San Diego are plotters. The big plotters for schematics...

MJ Right

RS [Entering room] This is all the Singapore stuff here.

MJ Okay.

RS And then uh, this is the tape drive, so somewhere in here must be that board that you're trying to build. Well, somewhere in this machine.

MJ Oh. Oh, okay.

RS Well, somewhere in this machine.

E This one.

RS Oh, okay. Oh, it's stuck on to the machine, huh? So you, were you going to take this down with you? Or just look at it?

E Just look at it, because if we take it down there is something will happen in the system?

RS I don't know. I didn't realize it was hooked on to something here. I don't know that much about it. I think we could... it doesn't look like it's connected by anything other than the fingers, you could probably just pull it out. You want to take it with you.

E [softly] Of course.

RS Yes?

E Yes.

RS Okay.

E [holds up drawings next to board] I did the right drawings.

MJ Yeah, you did the right drawing.

E See, that, you know, when I first bend the part in the middle? Should be ninety degree, not like what Maggie is telling, instead of adding a short, short piece of wire, a solid wire, to lap solder it as Wade said to me.

RS But you still want a radius in there, you don't want a hard ninety degree angle, right?

E But this one looks like, looks like ninety degree radius.

MJ But it has also got that larger pad, whereas yours only has the little circle, right?

E Yeah, the little circle.

MJ Yeah.

E So that's in place of the pad, of the uh

RS Do you want to take it with you?

E There's no harm in taking it out, or?

RS Ah, I don't think so. It should have my name on the back of it. Where…? Where's the tag? These are supposed to be tagged. That's weird. I mean, it says customer sample, but it's supposed to have one of these tags. It's a customer consigned part because it is a sample board. So, for some reason it's not tagged, I don't know what the reason is. Go ahead and take it. If you can get it out. [RS and MJ watch as Eduardo pulls the board out of its socket.] Okay? And then what I'll do is, I'll write a note, and stick it right here saying that, um, that

E Because that's the guy, William? The other guy working here and ah I told him to get, to borrow this board if I can, but he said to me, "It's plugged into the system, so better ask Jack Sutton." So I, Oh.

RS Yeah, well William doesn't really work in here anyway.

E Oh, really? But, uh

RS He's pack out.

E He just helped me out because I had a question

RS Oh.

E because I am looking for this

RS The guy, the guy that you want to talk to is Skinny. Do you know Skinny? He is the guy that runs the functional testing.

E Maybe I wasn't able, I wasn't able to meet her or him or...

RS It's a him. He's a Vietnamese guy.

MJ Oh.

RS His name is Thinh.

E Thinh

RS Thinh. T-H-I-N-H.

MJ So they call him Skinny.

RS They call him Skinny, oh, but he's not skinny, he's real... yeah, he works out and everything. He's strong you know. It's kind of a funny name, that they call him Skinny and you look at him, it doesn't fit, they should call me that.

MJ (laughs)

RS So I'll put a note here, to say that Maggie has the boards, so we'll make her responsible, how's that.

E I guess that would be okay. It would be fine.

RS And then, I'll look and see if I have that, a copy of that memo, but it might have gone directly to the engineer. I'm not sure. I've just had too much paper come across my desk. So I'll find out if I have that authorization letter. But I think given the sample, if you work from the sample, by the time you finish this, you know, it's not going to ship it tonight anyway, it's got come up and be tested and everything.

E Actually this board, just after from second ops just go right here, SMO, so nobody will look at the board. I don't know if there's some other guys will be working on it.

RS Well, what I am saying is you can go ahead and do the work, and then tomorrow morning, if I don't find the letter tonight, tomorrow morning the engineer will be here to answer any questions anyway.

E Okay.

RS And so we'll get it passed one way or another.

E Okay.

RS All right? But if I find it I'll bring it down and give it to Maggie.

E Okay. Thanks.

RS Sure. Let's leave this open so I can put a note in there.

MJ Oh, okay.

E Okay. Thank you , thank you, Rod.

[Eduardo and MJ return to manufacturing floor, RS to his cubicle.]

E I did the drawing.

MJ Yeah, you got the right drawing. Your schematic is flawless. (laughs)

E (…) You know the the difference is all, all, on the board we're working on up there is only small small land- or pad is covered with the masking.

MJ Yeah

(sounds of walking, door shutting)

E I think Maggie have a point, you know, of not making a ninety degree bend

MJ Um hm

E Because the smooth

MJ So you don't have to do a lap solder.

E Don't have to do a lap solder. More reliable than this

MJ And like she said, it would be harder.

E Harder to get that on here

MJ Harder to get that little pad heated up enough to get the lap solder would probably

[Back on the manufacturing floor, Eduardo proceeds to instruct his workers on procedures for the board. MJ joins Maggie, who is trying to convince Pong Chi that some of the boards the workers in second ops have rejected and sent for rework are not rejects. Maggie tells Pong Chi to put the boards on hold until she checks the workmanship standards. Maggie returns to her office, followed by MJ, where she spends the next few minutes reviewing the standards, reassuring herself that she's right. Eduardo shows up shortly with a new sample board, one he has built using the new parts and based on the earlier discussion, his drawings, and the SMO board. Maggie approves of the sample. They review their decision and their frustrations with Wade's inadequate documentation. The following section begins just into side A of EMCO tape # 101.]

[Eduardo appears in the doorway, new sample board in hand.]

E 'Scuse me.

M Hello.

E Hello. (…) [shows Maggie the new board]

M Huh? Right on.

E Uh huh. Good enough, huh?

M That, that looks good.

E Oh, I didn't bring you the sample.

M Oh, I don't need the sample. 'Cause I know that, uh, yeah. This

E 'Cause, you know what, the area, this area is all exposed, like metal like this one, but this one they put masking on. Maybe this one quite cheaper than the other, the other previous.

M Put masking on? What do you mean? Oh, masking on on on this board here?

E Yeah, on this board there is a masking. The other one is look like, look like the one, metal.

M And uh what'd they have on it, then a tubing or whatever?

E No, they can solder up to this much, but they can't solder

M Oh, oh, I see. Yeah, looks good. Fast down and dirty, too, huh. Yeah, looks good. Very good. Heh heh heh heh. [dramatic voice] And nothing stops us, even on swing shift. Dun-dun-dun-dun:.

E Instead of, [in voice of disbelief] put a short wire, then lap-

M Can you- yeah.

E Could you imagine it takes time putting on that…?

M Oh, yeah, especially a little tiny wire, you're gonna ov- you're gonna lap it onto uh uh on that wire there? And then try and heat up the the wire onto the pad and it's gonna move, it's gonna come off, it's gonna come off- p-t-t-t-t-t-t.

E Plus, remember the sample board, the same the same board they did last time, so they didn't have much problem on this one but now we got this batch so they didn't even think that we be getting this kind of, you know, this kind of batch.

M Well, even though, I mean, uh, Rod had information about those two part numbers which was quite interesting and uh showing no deviation or whatever in our passdown to use those. So, obviously, someone has slipped on getting their job done. I mean, he signed that, he signed that paper. Wade O'Malley did. Approved the two part numbers, but, uh-

[Custodian interrupts at this point, asking Maggie to come out and check his area. Eduardo leaves. Maggie tells him once more, as he leaves, "Good job, Eddie." See Maggie's passdown from this evening for her brief summary of the event.]

APPENDIX I: LINE-BY-LINE ANALYSIS
OBSOLETE DOCUMENTS EVENT

Line Number	Literate Activities	Functions	Documents Used	Participants	Description, New Codes, Questions
		Obsolete Documents Event			
NA	Reads passdown	Receiving Direction	Passdown	Maggie, Eduardo	
NA	Reads schedule board	Receiving Direction	Schedule Board	Eduardo	
NA	Reads MPI	Receiving Instruction	Drawings; BOMs; ECNs; Etc.	Eduardo	
NA	Finds kit by number	Identifying	BOM	Eduardo	
NA	Checks Kit Parts Against MPI	Identifying; Verifying		Eduardo	New Code: Identifying: Matching the physical with the representation
NA	Asks engineer for clarification	Clarifying		Eduardo	
NA	Reads sample board	Interpreting		Eduardo	
NA	Creates assembly drawing	Representing		Eduardo	
NA	Writes a list of parts	Identifying; Translating		Eduardo	New Code: Translating from one representation to another
NA	Matches parts on list with kit	Verifying		Eduardo	
9—12	Refer to Board	Referencing	Assembly	Eduardo, Maggie	Eduardo enters Maggie's office, carrying board and documentation
17-18	Refers to Board & Drawing, Cites Kit; Tries to make sense of drawings and instructions in light of available parts	Referencing; Citing; Interpreting	Drawings; Assembly; Components	Eduardo	
19-21	Discuss production history of particular assembly	Contextualizing	Assembly	Maggie, Eduardo	New Code: Providing an historical or situational context for a representation or literate activity
23-27	Read MPI, find corresponding sections on drawing, compare with assembly and components	Identifying; Interpreting; Referencing	MPI; Drawing; Assembly; Components	Eduardo, Maggie	Add to "Referencing" Code: Referring to one or more representations or literate activities in order to explain, highlight or call into question something in another representation or literate activity
28-41	Explains which component and which part of the process presents a problem	Explaining	Assembly; Components	Eduardo	

APPENDIX I: LINE-BY-LINE ANALYSIS
OBSOLETE DOCUMENTS EVENT

Line Number	Literate Activities	Functions	Documents Used	Participants	Description, New Codes, Questions
42-53	Refers to board in SMO lab, recounts steps taken to locate sample board	Recounting; Citing	Assembly; Customer Consignment Tag	Eduardo	New Code: Recounting: Reviewing, with some narrative detail, a literate activity
54-59	Discuss comparisons between sample board in fRodt of them and sample board in SMO lab	Referencing	Assemblies	Eduardo, Maggie	
64-66	Resolve questions about customer and responsible engineer	Requesting & Providing Clarification	Assembly	Maggie, Eduardo	
73-77	Explains inaccessibility of sample board he wishes to examine	Explaining; Citing	Assembly	Eduardo	
78-84	Clarify understandings of how components should be installed; explain by cross-referencing with sample board in SMO lab	Requesting Clarification; Demonstrating; Referencing	Assembly; Components	Maggie, Eduardo	
84-89	Speculate about how others might have carried out process; Contemplate alternatives	Conjecturing	Assembly; Components	Eduardo, Maggie	
89-93	Discuss production history of assembly	Contextualizing	Assembly	Maggie, Eduardo	
94-140	Interpret & try to reconcile discrepancies among written instructions, assembly drawing, Wade's oral instructions, recollections of locked-up sample board, and available assembly & components	Problem-Solving; Referencing; Interpreting; Citing; Explaining	MPI; Assembly Drawings; Assemblies; Components	Eduardo, Maggie	New Code: Problem-solving: Drawing on literate resources in conjunction with background knowledge to construct a problem solution
141-142, 146, 148-155	Wavers, wondering if their solution matches the sample they can't get to and worrying that they're not following Wade's instructions	Gauging Reaction	Assembly	Eduardo	New Code: Considering alternate interpretations of, reactions to and potential fall-out from problem solutions
121-122, 124, 143, 147, 152-161	Evaluates their product, gauging it agains what she imagines they'd get following Wade's directions	Evaluating	Assembly	Maggie	

APPENDIX I: LINE-BY-LINE ANALYSIS
OBSOLETE DOCUMENTS EVENT

Line Number	Literate Activities	Functions	Documents Used	Participants	Description, New Codes, Questions
161-166	Identifies component by double-checking with Eduardo, the MPI, assembly drawing, and component	Identifying	MPI; Assembly Drawing; Components	Maggie, Eduardo	
167-175	Asks for feedback on proposed solution, offers another evaluation	Gaining Consensus; Evaluating	Assembly	Maggie	
175-179	Discuss comparison between assembly in fRodt of them and assembly the SMO lab	Referencing; Citing; Requesting Clarification	Assemblies	Maggie, Eduardo	
180-184	Explains uncertainty in terms of memory of sample board	Explaining; Referencing	Assemblies	Eduardo	
188-189	Evaluates proposed representation	Evaluating	Assembly	Maggie	
189-192	Assesses chances of procedure passing engineer's scrutiny	Gauging Reaction	Assembly	Maggie	
194-213	Critique Wade's representations	Critiquing; Referencing	Assembly Drawing; MPI	Eduardo, Maggie	
214-215	Refers to discrepencies between components and drawings	Referencing; Identifying	Components; Assembly Drawings	Eduardo	
214-219	Recounts earlier attempts to locate and gain access to sample board	Recounting	Assemblies; Assembly Drawings	Eduardo	
221-223, 227	Peruses MPI, re-reading parts aloud	Perusing	MPI	Maggie	
225, 226, 228-230	Refers to production history of assembly	Contextualizing	Assembly	Eduardo	
230-232	Critique asembly drawing	Citing; Critiquing	Assembly Drawing	Eduardo, Maggie	
232-236	Read MPI to determine when it was last updated	Referencing; Interpreting	MPI; Assembly Drawing	Maggie, Eduardo	
237-244	Express frustration over out-dated and confusing MPI and unavailability of authoring engineer	Critiquing	MPI	Eduardo, Maggie	

APPENDIX I: LINE-BY-LINE ANALYSIS
OBSOLETE DOCUMENTS EVENT

Line Number	Literate Activities	Functions	Documents Used	Participants	Description, New Codes, Questions
245-254	Verify components	Verifying	MPI; Assemblies	Maggie, Eduardo	
260	Looks for notation on MPI	Locating	MPI	Eduardo	??In need of new definition for locating??
261	Gets Program Manager's name from MPI	Identifying	MPI	Maggie	Add to "Identifying" Code: Using a representation to identify person(s) associated with a representation or literate activity
261-266	Reads MPI to determine what's missing & what's outdated	Interpreting	MPI	Maggie	
266	Proposes writing note to engineer	Proposing	Passdown	Maggie	
266-267	Asks how to proceed	Seeking Direction	Assembly	Eduardo	New Code: Seeking direction in carrying out a literate activity.(Eduardo asks if they should install all components as discussed, or install only the 4 uncontroversial components and await instruction from Wade on the one in question)
268-275	Tells how to proceed	Giving Direction B; Referencing; Justifying; Citing	Assembly; BOM; MPI	Maggie	New Code: Giving Direction B: Telling another what to do with respect to a literate activity. Maggie tells Eduardo to proceed as they've discussed, that they can inform Wade later
281-284	Frets about accuracy of earlier observations of sample board in SMO lab	Citing	Assembly	Eduardo	
288-311	Displays and answers questions about personal (unofficial) documents (drawings & lists) drawn from sample board in SMO lab	Referencing; Recounting; Explaining; Justifying	Personal Documents	Eduardo, Maggie, Researcher	
299, 313, 315	Gushes over Personal (unofficial) Documents	Bestowing Blessings	Personal Documents	Researcher	New Code: Declaring a literate activity good and worthy of time spent
316-322	Continue to discuss Personal (unofficial) Documents	Explaining; Justifying; Critiquing	Personal Documents	Eduardo, Maggie	New Code: Showing or expressing disapproval or finding fault with a representation or literate activity

APPENDIX I: LINE-BY-LINE ANALYSIS
OBSOLETE DOCUMENTS EVENT

Line Number	Literate Activities	Functions	Documents Used	Participants	Description, New Codes, Questions
323-330	Gushes further, requests copies of Personal (unofficial) Documents	Bestowing Blessings; Requesting Documentation	Personal Documents	Researcher	
332-335	Recounts creation of unofficial documents	Recounting	Personal Documents; Kit; Assembly	Eduardo	
344-363	Critique documentation	Critiquing; Referencing; Citing	MPI; MOP	Eduardo, Maggie	
366-373	Briefly explains problem, asks for help	Referencing; Explaining; Seeking Direction	Assembly; MPI; Assembly Drawing	Maggie	
385-386	Refers to production schedule	Citing	Production Schedule (Passdown; Schedule Board)	Maggie	
409-410	Again asks for direction	Seeking Direction	Assembly	Maggie	
419-432	Explains problem, refers to various documents and processes	Explaining; Referencing; Referencing	Assembly Drawings; MPI; Assembly	Eduardo	
433-434	Requests clarification	Requesting Clarification	Components	Rod	
435-436	Provides requested information by referencing personal (unofficial) documents	Providing Clarification	Personal Documents	Eduardo	
437-441	Verifies component by referencing project notebook, cross-referencing documents within notebook	Verifying; Referencing	Project Notebook--ECN's, BOM's, Deviations, Transfers	Rod	
442-445	Provides background information as he searches for written authorization	Contextualizing; Citing; Locating	Written Authorization; Assembly	Rod	
445-446	Refers to sample board	Citing	Assembly	Rod	
447-456	Refers to sample board, requests access to it	Citing; Requesting Documentation	Assembly	Eduardo	

APPENDIX I: LINE-BY-LINE ANALYSIS
OBSOLETE DOCUMENTS EVENT

Line Number	Literate Activities	Functions	Documents Used	Participants	Description, New Codes, Questions
457-465	Verify components	Verifying	Project Notebook	Rod, Eduardo, Maggie	
466-476	Inquire about deviation, discuss access to sample board	Requesting Documentation; Citing	Deviations; MPI; BOM	Rod, Eduardo	
477-496	Recounts oral instructions & subsequent examination of sample board	Recounting; Citing	MPI; Assemblies	Maggie	
497-505	Requests access to sample board	Requesting Documentation	Assembly	Eduardo	
512-515	Refers to authorization letter among "bunch of stuff" yet to be filed in project notebook	Citing	Authorization Letter; Scatter of Documents; Project Notebook	Rod	
650-655	Locate sample board in system	Locating	Assembly	Eduardo, Rod	
655-666	Asks if Eduardo's requesting permission to take sample board with him, grants permission	Requesting Permission; Granting Permission	Assembly	Rod, Eduardo	
667	Checks drawing against sample board	Verifying	Personal Documents; Assembly	Eduardo	
669-678	Read sample board, comparing it with the new board, with Wade's instructions, and with Maggie & Eduardo's proposed process	Interpreting; Referencing	Personal Documents; Assemblies	Eduardo, Rod	
679-697	Wonders about missing consignment tag, grants permission to check out the sample board	Proposing B; Granting Permission	Customer Consignment Tag; Assembly; Note Consigning Assembly to Maggie	Rod	
688-698	Explains earlier request to transfer sample board	Explaining; Requesting Permission	Assembly	Eduardo	

APPENDIX I: LINE-BY-LINE ANALYSIS
OBSOLETE DOCUMENTS EVENT

Line Number	Literate Activities	Functions	Documents Used	Participants	Description, New Codes, Questions
710-711	Gives board to Eduardo and proposes signing it out to Maggie	Proposing; Recording; Protecting	Assembly; Note Consigning Assembly to Maggie	Rod	New Code: Protecting:Using or creating a document to protect oneself from blame—assigning responsibility to another, documenting a course of action, etc.
713-730	Relies on memory of change order, OK's deviation on work process, refers to proposed note transferring responsibility to Maggie	Citing; Justifying; Granting permission	Scatter of Documents; Authorization Letter; Assembly; Note Consigning Assembly to Maggie	Rod	Add to"Granting Permission Code": Granting permission to revise or engage in an alternative to a controlled literate activity
734-737	Evaluates personal (unofficial) drawing	Evaluating	Personal Document	Eduardo	Note difference between "evaluating", "assessing" (below), and "critiquing" (lines 778+)
740-747	Assesses Maggie's proposed alternative to Wade's instructions	Assessing	Assembly	Eduardo	
NA	Creates new sample board	Representing	Assembly	Eduardo	Note difference between this creation of sample board as "representing" and Hee-Fon's as "copying" (see Rework event, tape 81, lines 227-238)
761-776	Examine sample board done according to new process	Evaluating; Citing	Assemblies	Eduardo, Maggie	
778-791	Critique Wade's instructions and the obsolete & incomplete documentation	Critiquing; Citing	Assembly; MPI; Deviations; Passdown; Authorizations	Maggie, Eduardo	
NA	Makes notes on old passdown, then writes new passdown to day shift supervisor	Recording; Protecting; Requesting Action	Passdown; Personal Documents	Maggie	About Requesting Action & Proposing: Note difference between this (actually writing the note) and line 266 where she only proposes it

APPENDIX J: TAXONOMY OF FUNCTIONS OF LITERACY AT EMCO AND TEAMCO

Literacy Codes	Code Definition
Actioning	Accepting or assigning responsibility by committing in writing
Admonishing	Admonishing an individual or group about possible or actual violations of documented procedures
Analogizing	Comparing representations, processes or activities in order to illustrate a point or facilitate understanding
Assessing	Assessing an individual's or group's understanding of a representation or literate activity
Assigning	Assigning responsibility for authoring a representation
Bestowing Blessings	Declaring a literate activity good and worthy of time spent
Brainstorming	Individually or collaboratively constructing a representation for heuristic purposes
Calculating	Doing calculations (whether adding and subtracting or figuring standard deviations) not in service of themselves but as an integral part of literacy-related problem solving (e.g., for setting, adjusting or justifying production schedules or team goals)
Categorizing	Sorting something in order to classify
Certifying	Using a representation to attest to an individual's particular competence(s)
Citing	A) Referring to a representation that is not at hand; B) Referring to a literate activity not at hand
Coaching	Facilitating a literate activity or the understanding of a representation
Completing Forms	Completing routine forms
Conjecturing	Inferring, theorizing, predicting or guessing based on limited data
Constructing Rules	Constructing a rule regarding the use or interpretation of a representation or literate activity
Contextualizing	Providing an historical or situational context for a representation or literate activity
Copying	Copying a representation from one medium to another without qualitatively changing the representation
Correcting	Ridding a representation of errors
Creating Hypotheticals	Creating a hypothetical comparison of representations or literate processes or activities
Critiquing	Showing or expressing disapproval of or finding fault with a representation or literate activity
Deferring	Yielding to the opinions or direction of another regarding a representation or literate activity
Demonstrating	Demonstrating a literate activity for purposes of explanation, clarification or instruction
Disputing	Questioning, doubting, debating and/or resisting the opinion or direction of another regarding a representation or literate activity
Dramatizing	Explaining a representation or literate process by using a fictionalized example
Elaborating	Explaining a representation by drawing upon details not present in the representation
Evaluating	Evaluating the quality of a representation or literate activity

APPENDIX J: TAXONOMY OF FUNCTIONS OF LITERACY AT EMCO AND TEAMCO

Literacy Codes	Code Definition
Exhibiting	Demonstrating a point by passing around a sample representation, as in show-and-tell
Explaining	Using or referring to a representation or literate activity in explaining something to another person
Fudging	Creating a deliberate misrepresentation
Gaining Consensus	Gaining and recording group agreement
Gauging Reaction	Considering alternate interpretations of, reactions to and potential fall-out from problem solutions
Giving Direction	A) Writing directions for what to do; B) Telling another what to do with respect to a literate activity
Giving Instruction	A) Writing instructions for how to do something; B) Telling another how to go about a literate activity
Granting Permission	Granting permission to alter or transfer a controlled representation or to revise or engage in an alternative to a controlled literate activity
Highlighting	Emphasizing an aspect or aspects of a representation or of a literate activity
Identifying	Matching the physical with the representation
Illustrating	Using a representation to illustrate a point
Inferring	Inferring or predicting consequences based on an understanding of causes and effects
Interpreting	Understanding a representation in terms of its purpose or function A) within a work process or B) within the organization's hierarchical structure
Invoking	Invoking an organizational rule, script, procedure or personal understanding of how to carry out a literate activity
Irony	Drawing on understanding of another literate function to make a joke
Justifying	Drawing on forms of representation to justify a course of action
Keyboarding	Entering any type of information using a keyboard
Labeling	Creating a representation in order to identify
Locating	Looking for a particular representation, which should exist, to satisfy a particular function
Looking Something Up	Finding information in a document
Matching	Checking that a physical item and a representation match
Miming	Gesturing to represent another representation or a literate activity
Notetaking	Taking notes during work processes, class or training for personal reference later. Notes may serve any of a variety of functions, including highlighting, translating, reminding, simplifying, correcting...)
Perusing	Reading or studying a representation
Planning	Working from a representation to plan a course of action
Practicing	Participating in literate activity solely for purpose of becoming proficient at process; "product" not intended for use
Presenting	Using a representation to structure an oral presentation
Problem-solving	Drawing on literate and/or numerate resources in conjunction with background knowledge to construct a problem solution

APPENDIX J: TAXONOMY OF FUNCTIONS OF LITERACY AT EMCO AND TEAMCO

Literacy Codes	Code Definition
Proofreading	Scanning a representation for errors
Proposing	Creating a representation to propose an idea or course of action, or proposing the creation of a representation as a course of action
Protecting	Using a document to protect oneself from blame—assigning responsibility to another, documenting course of action, etc.
Providing Linguistic Assistance	Aiding someone in decoding and/or pronouncing written material
Quoting	Drawing on or invoking company discourse to legitimate an idea, suggestion or position
Receiving Instruction	Receiving instruction on how to do something
Reciting	Reciting from a written text (e.g., blackboard, workbook, flipchart, overhead)
Recording	Making note of an action
Recounting	Reviewing, with some narrative detail, a literate activity
Referencing	Referring to representations, literate activities or processes at hand
Reflecting	Reflecting on some aspect (e.g., process, intention, efficacy) of a literate activity some time after the activity has been completed
Representing	Creating a representation of something else
Reprimanding	Writing a document that can have a disciplinary consequence
Requesting Action	Writing something to request action from another
Requesting and/or Providing Clarification	Requesting and/or providing clarifying information about a representation or literate activity
Requesting Documentation	Requesting a representation for use or perusal
Requesting Permission or Approval	Requesting permission to alter or transfer a controlled representation or to revise or engage in an alternative to a controlled literate activity; requsting approval of such an alteration
Revising	Modifying or updating a process or document
Role Playing	Taking on the role of another person in order to enact a scripted hypothetical work scenario
Seeking Direction	Seeking direction from some authority in carrying out a literate activity
Seeking Instruction	A) Seeking written instructions; B) Seeking instruction from another in how to carry out a literate activity
Show-and-Telling	Demonstrating by passing around a sample representation, as in show-and-tell
Signifying	Matching up two signs for the same object
Summarizing	Recapping the content of a representation, or using a representation to recap a process or activity
Tallying	Doing calculations to serve limited literacy-related ends (e.g., to complete forms) in isolation from the larger problem-solving contexts for which the data will be used
Translating	Translating from one representation to another
Validating	Sanctioning an idea or action proposed in or through a representation
Verifying	Checking one's understanding of a representation, literate process or activity

APPENDIX K: META-CATEGORIES OF LITERATE FUNCTIONS AT EMCO AND TEAMCO

Performing Basic Literate Functions	Using Literacy to Explain	Taking Part in Discourse Around & About Text	Participating in Flow of Information	Problem Solving	Exercising Critical Judgment	Using Literacy to Exercise, Acknowledge or Resist Authority
Completing Forms	Analogizing	Citing (A) (B)	Coaching	Brainstorming	Assessing	Actioning
Copying	Contextualizing	Constructing Rules	Constructing Rules	Calculating	Bestowing Blessings	Admonishing
Correcting	Demonstrating	Highlighting	Giving Instruction (A) (B)	Categorizing	Certifying	Assigning
Identifying	Dramatizing	Miming	Invoking	Conjecturing	Critiquing	Constructing Rules
Keyboarding	Elaborating	Perusing	Practicing	Creating Hypotheticals	Disputing	Deferring
Labeling	Exhibiting	Presenting	Providing Linguistic Assistance	Gauging Reactions	Evaluating	Fudging
Locating	Explaining	Quoting	Receiving Instruction	Justifying	Highlighting	Gaining Consensus
Looking Up	Illustrating	Recounting	Requesting/Providing Clarification	Planning	Inferring	Gauging Reactions
Matching	Role Playing	Referencing	Seeking Direction	Problem Solving	Interpreting	Giving Direction (A) (B)
Notetaking	Show-and-Telling	Reflecting	Seeking Instruction (A) (B)	Representing	Irony	Granting Permission
Practicing		Signifying		Revising	Validating	Interpreting B
Proofreading		Summarizing			Verifying	Invoking
Providing Documentation						Irony
Reciting						Proposing
Recording						Protecting
Requesting Documentation						Reprimanding
Tallying						Requesting Action
Translating						Requesting Permisison or Approval

APPENDIX L: META-CATEGORY PARTICIPANT GRID
WAVE TEAM MEETING

Episode	Participants	Performing Basic Literate Functions	Using Literacy to Explain	Taking Part in Discourse Around & About Text	Participating in Flow of Information	Problem Solving	Exercising Critical Judgment	Using Literacy to Exercise, Acknowledge or Resist Authority
TEAMCO: Wave Team Meeting, Including Fishbone Diagram of Solder Ball Problem								
1: Opening Procedures (Getting Settled, Taking Attendance, Reviewing Minutes & Agenda	Carlos			Referencing, Citing A (2), Citing B				Invoking (2)
	Dai			Summarizing (2), Referencing (2), Citing A (5), Citing B			Bestowing Blessings	
	Leon			Citing (A)				Irony
	Other Team Members (6) & Mr. Po							
2: Initiating & Discussing a Problem	Dai		Explaining	Citing A, Citing B				Invoking, Admonishing
	Leon		Explaining	Citing B	Requesting Clarification	Justifying		
	Other Team Members (7) & Mr. Po							

APPENDIX L: META-CATEGORY PARTICIPANT GRID
WAVE TEAM MEETING

Episode	Participants	Performing Basic Literate Functions	Using Literacy to Explain	Taking Part in Discourse Around & About Text	Participating in Flow of Information	Problem Solving	Exercising Critical Judgment	Using Literacy to Exercise, Acknowledge or Resist Authority
3: Initiating & Discussing a Problem	Carlos	Requesting Documentation	Explaining (2)	Citing A (4), Citing B (4), Referencing, Miming		Problem-Solving		
	Yiheng			Citing A (2), Perusing, Signifying		Conjecturing		
	Dai	Locating				Conjecturing		
	Leon			Perusing, Citing A (2), Citing B (2) Miming		Conjecturing (2)		
	Hoang	Requesting Documentation		Perusing				
	Other Team Members (4) & Mr. Po							
4: Formally Brainstorm Causes of Problem	Carlos			Referencing , Citing A & B, Perusing	Coaching	Brainstorming		Proposing B
	Dai		Explaining	Referencing, Citing A, Citing B (2), Perusing		Brainstorming	Assessing	Gaining Consensus
	Leon			Referencing, Citing A & B, Perusing		Brainstorming		

APPENDIX L: META-CATEGORY PARTICIPANT GRID
WAVE TEAM MEETING

Episode	Participants	Performing Basic Literate Functions	Using Literacy to Explain	Taking Part in Discourse Around & About Text	Participating in Flow of Information	Problem Solving	Exercising Critical Judgment	Using Literacy to Exercise, Acknowledge or Resist Authority
	Juan			Referencing, Citing A & B, Perusing	Requesting CLarification	Brainstorming		
	Yiheng			Referencing, Citing A & B, Perusing		Brainstorming		
	Macario			Referencing, Citing A & B, Perusing		Brainstorming		
	Other Team Members (3) & Mr. Po			Perusing				
5: Listing Solutions to Brainstormed Causes	Carlos			Summarizing, Citing A, Perusing		Brainstorming		Invoking
	Juan	Proofreading, Correcting		Perusing				
	Leon	Proofreading, Correcting		Citing A, Perusing	Providing Linguistic Assistance	Brainstorming		
	Macario			Citing A, Perusing		Brainstorming		
	Yiheng			Citing A, Perusing		Brainstorming		

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APPENDIX L: META-CATEGORY PARTICIPANT GRID
WAVE TEAM MEETING

Episode	Participants	Performing Basic Literate Functions	Using Literacy to Explain	Taking Part in Discourse Around & About Text	Participating in Flow of Information	Problem Solving	Exercising Critical Judgment	Using Literacy to Exercise, Acknowledge or Resist Authority
	All Team Members (9) & Mr. Po			Perusing				
6: Reviewing & Evaluating Solutions	Carlos			Summarizing, Perusing				
	Leon			Miming, Perusing	Providing Linguistic Assistance, Coaching			
	Juan			Highlighting, Perusing			Highlighting	
	Ernesto	Copying						
	Mr. Po			Citing B, Highlighting, Perusing			Highlighting (2), Bestowing Blessings	
	Dai			Referencing, Perusing				Gaining Consensus
	Other Team Members (4)			Perusing				
7: Wrapping Up (Setting Future Agenda & Announcing Upcoming Events	Leon			Citing A				Invoking
	Yiheng						Irony	

APPENDIX L: META-CATEGORY PARTICIPANT GRID
WAVE TEAM MEETING

Episode	Participants	Performing Basic Literate Functions	Using Literacy to Explain	Taking Part in Discourse Around & About Text	Participating in Flow of Information	Problem Solving	Exercising Critical Judgment	Using Literacy to Exercise, Acknowledge or Resist Authority
	Dai	Recording		Citing A & B		Planning		
	Mr. Po			Citing B (2)				Admonishing (2)
	Carlos			Citing B				Admonishing
	Other Team Members (5)							

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APPENDIX M: WORKSHEET— META-CATEGORY FREQUENCIES BY PARTICIPANT WAVE SOLDER TEAM MEETING

Performing Basic Literate Functions	Using Literacy to Explain	Taking Part in Discourse Around & About Text	Participating in Flow of Information	Problem Solving	Exercising Critical Judgment	Using Literacy to Exercise, Acknowledge or Resist Authority	Totals
Carlos (1)	Carlos (2)	Carlos (25)	Carlos (1)	Carlos (3)		Carlos (5)	37
Dai (4)	Dai (2)	Dai (19)		Dai (3)	Dai (2)	Dai (4)	34
	Leon (1)	Leon (18)	Leon (4)	Leon (5)		Lope (2)	30
		Yiheng (12)		Yiheng (3)	Yiheng (1)		16
Juan (2)		Juan (8)	Juan (1)	Juan (1)	Juan (1)		13
		Mr. Po (5)			Mr. Po (3)	Mr. Po (2)	10
		Macario (7)		Macario (2)			9
Hoang (1)		Hoang (4)					5
Ernesto (1)		Ernesto (1)					2
		Dam (1)					1
9	5	100	6	17	7	13	157

APPENDIX N: META-CATEGORIES PARTICIPANT GRID
OBSOLETE DOCUMENTS EVENT

Episode	Participants	Performing Basic Literate Functions	Using Literacy to Explain	Taking Part in Discourse Around & About Text	Participating in Flow of Information	Problem Solving	Exercising Critical Judgment	Using Literacy to Exercise, Acknowledge or Resist Authority
EMCO: Obsolete Documents Event								
1: Preparing for Routine Work Process	Eduardo	Identifying A (3), Verifying A (2), Representing, Translating			Receiving Direction (2), Receiving Instruction, Requesting Clarification		Interpreting	
	Line Workers (10)							
2: Presenting Problem to Supervisor	Eduardo	Identifying A,	Contextualizing Explaining (2), Recounting, Demonstrating	Referencing (5), Citing A (3), Citing B	Providing Clarification		Interpreting (2)	
	Maggie			Referencing (2)	Requesting Clarification (2)			
	Line Workers (10)							
3: Brainstorming Possible Solutions	Maggie		Explaining, Contextualizing	Referencing, Citing A		Conjecturing, Problem-Solving	Interpreting	
	Eduardo		Explaining, Contextualizing	Referencing, Citing A		Conjecturing, Problem-Solving	Interpreting	
	Line Workers (10)							

APPENDIX N: META-CATEGORIES PARTICIPANT GRID
OBSOLETE DOCUMENTS EVENT

Episode	Participants	Performing Basic Literate Functions	Using Literacy to Explain	Taking Part in Discourse Around & About Text	Participating in Flow of Information	Problem Solving	Exercising Critical Judgment	Using Literacy to Exercise, Acknowledge or Resist Authority
4: Evaluating Proposed Solution, Gauging Engineer's Possible Reaction	Eduardo	Matching (2), Identifying, Locating	Explaining, Recounting, Contextualizing	Referencing (4), Citing A			Gauging Reactions, Critiquing (3), Interpreting	
	Maggie	Identifying, Matching, Looking Up		Referencing (3), Citing A (2), Perusing	Requesting Clarification		Evaluating (3), Critiquing (3), Interpreting (2)	Gaining Consensus, Gauging Reaction, Proposing
	Line Workers (10)							
5: Raising Doubts About Proposed Solution	Eduardo		Recounting (2), Explaining (2)	Citing A (2), Citing B, Referencing (2)	Seeking Direction, Receiving Direction	Justifying (2)	Critiquing (2)	
	Maggie			Referencing (3), Citing A (2)	Giving Direction B	Justifying	Critiquing (2)	
	Researcher	Requesting Documentation		Referencing				Bestowing Blessings (2)
	Line Workers (10)							

APPENDIX N: META-CATEGORIES PARTICIPANT GRID
OBSOLETE DOCUMENTS EVENT

Episode	Participants	Performing Basic Literate Functions	Using Literacy to Explain	Taking Part in Discourse Around & About Text	Participating in Flow of Information	Problem Solving	Exercising Critical Judgment	Using Literacy to Exercise, Acknowledge or Resist Authority
6: Seeking Direction from Higher Authority	Maggie		Explaining	Referencing, Citing A	Seeking Direction B (2)			
	Line Workers (10)							
7: Providing Higher Authority with Background Data	Eduardo		Explaining	Referencing	Providing Clarification			
	Rod				Requesting Clarification			
	Line Workers (10)							
8: Recounting & Verifying "Hidden" Literate Activities	Rod	Matching (2), Locating, Requesting Documentation	Contextualizing	Referencing, Citing A (4)				
	Eduardo	Requesting Documentation (3), Matching		Citing A (2)				
	Maggie	Matching	Recounting	Citing A & B				Bestowing Blessings

APPENDIX N: META-CATEGORIES PARTICIPANT GRID
OBSOLETE DOCUMENTS EVENT

Episode	Participants	Performing Basic Literate Functions	Using Literacy to Explain	Taking Part in Discourse Around & About Text	Participating in Flow of Information	Problem Solving	Exercising Critical Judgment	Using Literacy to Exercise, Acknowledge or Resist Authority
	Line Workers (10)							
9: Gaining Access to Sample Board	Eduardo, Rod	Locating						
	Line Workers (10)							
10: Requesting & Granting Authorization for Transfer of Sample	Eduardo	Matching	Explaining	Referencing			Interpreting	Requesting Permission (2)
	Rod	Recording		Citing A, Citing B, Referencing		Justifying	Interpreting	Granting Permission (3), Proposing (2), Protecting
	Line Workers (10)							
11: Creating New Sample Board	Eduardo	Representing					Evaluating, Assessing	
	Line Workers (10)							
12: Evaluating New Sample	Maggie			Citing A (2)			Evaluating	

APPENDIX N: META-CATEGORIES PARTICIPANT GRID
OBSOLETE DOCUMENTS EVENT

Episode	Participants	Performing Basic Literate Functions	Using Literacy to Explain	Taking Part in Discourse Around & About Text	Participating in Flow of Information	Problem Solving	Exercising Critical Judgment	Using Literacy to Exercise, Acknowledge or Resist Authority
	Eduardo			Citing A, Citing B			Critiquing	
	Line Workers (10)							
13: Reporting to the Next Shift	Maggie	Recording						Protecting, Requesting Action
	Line Workers (10)							

APPENDIX M: WORKSHEET—
META-CATEGORY FREQUENCIES BY PARTICIPANT
OBSOLETE DOCUMENTS EVENT

Performing Basic Literate Functions	Using Literacy to Explain	Taking Part in Discourse Around & About Text	Participating in Flow of Information	Problem Solving	Exercising Critical Judgment	Using Literacy to Exercise, Acknowledge or Resist Authority	Totals
Eduardo (10)	Eduardo (16)	Eduardo (27)	Eduardo (8)	Eduardo (4)	Eduardo (15)	Eduardo (2)	82
Maggie (5)	Maggie (4)	Maggie (22)	Maggie (4)	Maggie (3)	Maggie (12)	Maggie (6)	56
Rod (7)	Rod (1)	Rod (8)	Rod (1)	Rod (1)	Rod (1)	Rod (6)	25
Researcher (1)						Researcher (2)	3
23	21	57	13	8	28	16	166

APPENDIX P: TAXONOMY OF TEAM ACTIVITIES

Team Activities Codes	Code Definition
Accepting Responsibility	Accepting responsibility for a decision or a course of action
Acquiescing	Complying with or accepting a suggestion after an initial challenge
Admonishing	Scolding (sometimes lightly or in jest) an individual or team for a mistake or failure to comply
Aligning	One team member agreeing with another either against a third member or to show solidarity
Appointing	Appointing a person to participate in team meetings in a specific way such as being responsible for providing information, taking action, or making a decision
Assisting	Providing assistance, either linguistic or procedural, to another team member in understanding or completing a team process
Bestowing Blessings	Declaring a work process or team process good and worthy of time spent in a way that invokes the mantle of the traditional power structure
Clarifying	Seeking or providing clarification of an apparent misunderstanding or discrepancy within or between team procedures and/or activities
Collaborating	Several people working together interactively on a task
Complaining	Explaining or commenting upon a work situation or work process in ways that emphasize how it is problematic or in order to assign blame
Confirming Understanding	Confirming an understanding of directions or instructions, often by repeating, questioning, paraphrasing or miming
Conjecturing	Inferring, theorizing, predicting, or guessing based on limited data
Conscription	Enrolling the participation of reluctant team members through the use of persuasion, pressure, or coercion
Correcting	Calling attention to and correcting an error or misconception
Critiquing	Showing or expressing disapproval of or finding fault with a suggestion, decision, procedure or course of action
Defending	Offering a defense or rationale for one's own, a team's or a team member's actions
Deferring to authority	Deferring to a higher authority within the corporate structure in regard to making a decision or planning a course of action
Defining team boundaries	Advocating a position or taking action that A) enhances the team's ability to make decision and enlarges the scope of team influence or B) constrains the team's ability to make decisions and limits the scope of team influence
Delaying	Saying no to, delaying, or deferring a request or a directive
Digressing	Initiating a topic unrelated to team process
Directing/Focusing	Directing or focusing the activities of an individual or the whole team overtly or subtly

APPENDIX P: TAXONOMY OF TEAM ACTIVITIES

Team Activities Codes	Code Definition
Eliciting	Eliciting team input regarding a problem or a course of action
Entreating	Making an earnest request from an individual or the team for more investment in their work or the team process
Establishing consensus	Asking for whole team consensus regarding a decision
Exclaiming	Responding (often in chorus) to a comment or situation with high affect, demonstrating solidarity but offering no solution
Exerting authority/ Limiting team capacity	Limiting the subjects that a team can discuss or the actions that a team can take
Explaining	Explaining a work situation or work process to other team members
Focusing	Milder version of directing
Following team procedures	Following a procedure based on an individual or collective understanding of how to carry out team activities
Gossiping	Sharing information about people or activities obtained through informal channels
Informing	Informing team members of a new (or of changes in an existing) work situation or work process
Initiating	Initiating a new topic by raising a question or by offering information about, commentary on or critique of something not previously discussed in this specific context
Joking	Using team meetings as a forum for humor for the purposes of establishing collegiality
Justifying	Justifying a course of action or a procedure based on how other teams are doing the same or a similar thing or on one's understanding of team procedures.
Making Conversation	Social chit-chat, often occurring at beginning or end of meeting
Non-compliance	Not responding to a comment or a direct request, or refusing to comply with a direct request
Orienting	Providing an overview of a document, process, or machine
Paraphrasing	Paraphrasing a document or a team member's response in ways that clarify, amend, recast, translate, elaborate or lend support to
Providing inside information	Offering information or perspectives gained by virtue of one's position within the factory or membership on a team or committee
Providing personal information	Offering personal information or perspectives to or requesting it from an individual or the team
Questioning	Raising additional issues related to a topic in ways that complicate or deepen the level of the discussion
Recognition	Formally or officially recognizing the accomplishments of the whole team (ie team competitions)

APPENDIX P: TAXONOMY OF TEAM ACTIVITIES

Team Activities Codes	Code Definition
Referencing company organizational structure	Correcting a problem or justifying an action by referencing the organizational structure of the company in a way that highlights (a) the functions of other departments or (b) a power dynamic between departments or between positions within a department
Referencing personal work rules	Drawing an individual's or the group's attention to personal work rules or procedures, including literacy practices
Referencing team rules	Drawing an individual's or the group's attention to formal or informal team rules, to formal or informal team procedures, or to the language used by the company to describe SDWTs
Referencing work rules	Drawing an individual's or the group's attention to a formal or informal work rule or procedure for the purpose of reminding or chastising
Refuting	Denying the truth, accuracy, or logic of a statement made by an individual team member or a group of team members
Replying	Responding in a minimal way to a request for information (less forthcoming than necessary for "Responding")
Requesting	Asking politely that an action be performed
Requesting information	Asking for information from team member(s) about a work process or problem
Responding	Suggesting an idea or a course of action or supplying information related to a team decision, problem or discussion
Reviewing	Reviewing a process or an activity that has taken place earlier
Suggesting	Suggesting an idea or course of action in a self initiated manner
Surveying	Gauging collective experience or background knowledge by informally surveying team members, students or trainees
Taking responsibility	Taking responsibility for a decision or a course of action in a self-initiated, individual manner
Voluntarily participating	Offering information, commentary or critique or raising a question related to a topic already initiated
Welcoming	Welcoming new members of the team to the group

APPENDIX Q: TAXONOMY OF TRAINING CLASS ACTIVITIES

Training Class Codes	Code Definition
Answering/Obliging	Responding in a cooperative manner to a class member or to the teacher's request for participation
Assigning	Assigning responsibility for thinking about work in certain ways, i.e., for being a team player
Confirming	Confirming that what someone else has understood you to say is true
Following Class Procedure	Following pre-determined class procedures which constitute the regular class format
Hinting	Providing hints about answers to a question for which the questioner already has the answer
Lecturing	Speaking at length about a topic or a number of topics without yielding the floor
Mitigating	Assuring one's interlocutor that their knowledge of an activity or process is not required to be perfect, or that their response to something can be somewhat approximate and still be valid. Usually an effort to downplay the possibility of being "wrong"
Prompting	Prompting someone to respond in a way that has been pre-determined to be the correct way. More explicit and directive than
Reassuring	Reassuring someone that a process or activity will be okay.
Reciting	Reciting from a written text (blackboard, workbook, flipchart, overhead)
Referencing Class Procedures	Drawing an individual's or class' attention to class rules or procedures
Requesting Indirectly	Asking for something by making a leading statement, avoiding an explicit request
Requesting Permission	Requesting permission to do something that falls outside the bounds of normal classroom activities
Role Playing	Taking on the role of another person in order to enact a hypothetical work scenario
Validating	Repeating, rephrasing or responding in a way that validates the previous person's utterance, or confirms its correctness. This is the final third of the IRE sequence (as described in Bud Mehan's work).

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